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ABSTRACT

This curriculum guide provides resources that teachers and trainers can use to help learners improve their ability to apply mathematical problem-solving skills in the workplace. The instructional strategies and practice problems in the guide are patterned after those of the American College Testing (ACT) Work Keys System. Gains in skill levels can be measured by Work Keys assessments and by the assessment provided in this guide. The guide discusses the following information that will help instructors offer learners effective learning experiences: Work Keys; applied mathematics; proficiency outcomes; problem solving; instructional strategies; using practice problems; pretesting and posttesting; and resources for developing additional learning activities and practice problems. The instructional strategies and practice problems are divided by Work Keys level for improving through Levels 3-7. Five appendixes contain the following: (1) a list of 8 references; (2) lists of applied mathematics resources, such as 14 textbooks, 35 sources, 15 instructional computer software and laser disks, 9 suppliers of mathematics and science resources and materials, and 26 Internet sites; (3) 17 problem-based learning activities; (4) Ohio Mathematics Proficiency Outcomes; and (5) applied mathematics tests and answers. (KC)

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APPLIED MATHEMATICS

TARGETS FOR LEARNING

STRATEGIES
FOR PREPARING
SUCCESSFUL
PROBLEM
SOLVERS
IN THE
WORKPLACE

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Additions to Targets Are Encouraged

The learning activities and practice problems in *Targets for Learning: Applied Mathematics* were written by teachers, industry trainers, and industry employees. Targets was designed for use by both teachers and trainers who were educated to teach math and those who were not. In fact, Targets was intentionally published in a three-ring notebook format so that additional practice problems and learning activities can be integrated. As a user of Targets, you are encouraged to submit problems and activities that can be used in future editions of this book. In addition, your comments about the book's content are welcome. Submit suggestions and/or learning content to *Targets for Learning*, Vocational Instructional Materials Laboratory, 1900 Kenny Road, Columbus, Ohio 43210.

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Project Overview

Targets for Learning: Applied Mathematics was developed as part of an Ohio School-to-Work Partnership Prototype Grant. The project's goal was to develop resources that teachers and trainers could use to help learners improve their ability to apply problem-solving skills in the workplace. The practice problems and assessments were originally written by integrated teams of academic and vocational teachers in Cleveland Public Schools under the title of *Work-Based Intervention Strategies Kit* (WISK). The WISK problems were enhanced by project writers and supplemented with suggested instructional strategies. The instructional strategies and practice problems have been patterned after those of the ACT Work Keys System. Gains in skill levels can be measured by Work Keys assessments and/or the assessments provided in this book.

During the project, both *Targets for Learning: Applied Mathematics* and *Targets for Learning: Applied Technology* were written by teachers and industry representatives; piloted by vocational teachers, applied academics teachers, and industry trainers; and modified to reflect the knowledge gained during piloting. Both books are distributed by The Ohio State University's Vocational Instructional Materials Laboratory (VIML), which is part of the Center on Education and Training for Employment. The sales office can be reached by calling 800/848-4815 or faxing 614/292-1260.

In addition, the Vocational Instructional Materials Laboratory provides instruction and coaching to teachers and trainers, which prepares them to effectively use these materials. For further information, contact the VIML directly at 800/848-4815 or 614/292-5001.

Acknowledgments

Many people have devoted their time and talents to help make this book a useful resource for educators and trainers who wish to give learners opportunities to solve authentic math problems.

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TARGETS
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About This Book

Targets for Learning: Applied Mathematics was developed for teachers and industry trainers seeking strategies for preparing people to solve math-related problems in the workplace. The following explanation will help you to understand what this resource is all about:

- *Targets for Learning* was written for both math and **non-math teachers**. In other words, you don't need to have formal training in math to make full use of this book. However, even formally trained math teachers will find value in this book's practical focus on workplace applications.

- The skills addressed in *Targets for Learning: Applied Mathematics* are meant for **all learners**—not just those who are studying in technical areas (e.g., diversified health occupations, mechanics, manufacturing, business, graphics, construction). At home and at work, almost everyone encounters and needs to solve math-related problems. A few such challenges are balancing a checkbook, computing the tax on a sale, ordering materials, calculating cycle time, budget planning and reporting, and selecting the best buy from a range of options.

- *Targets for Learning* **supports what instructors are already doing** by offering ideas and materials for achieving their current goals and objectives. It is not a new program or a new curriculum—it is a resource that complements existing instructional efforts. *Targets for Learning* is not meant to be a complete curriculum. Instead, it supplements the curriculum by giving educators and trainers a wide variety of practice problems to use as needed. The problems can be used to reinforce basic skills, introduce problem-solving skills, and provide practice in solving problems similar to those on the Work Keys assessment.

- *Targets for Learning: Applied Mathematics* was developed with consideration for the Curriculum and Evaluation Standards for School Mathematics[1]. It helps learners become more effective problem solvers by targeting skills that have been identified in **national standards** and are measured by state proficiency tests.

- Each section of *Targets for Learning* identifies the specific **Ohio Math Proficiency Outcomes** that it addresses.

- *Targets for Learning* was designed to reflect the format of the **ACT Work Keys System**, which is described on pp. 5-12.

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[1] *Curriculum and Evaluation Standards for School Mathematics* (1989) was developed through the National Council of Teachers of Mathematics.

- *Targets for Learning* is presented in a 3-ring binder to enhance its usefulness to instructors. Users may wish to—
    - ✓ Change the order of the lessons to meet learners' needs and experiences
    - ✓ Add materials from other sources
    - ✓ Include personal notes about the instructional strategies used to teach the concepts and processes involved in applied math

Targets for Learning: Applied Mathematics includes a wide variety of information that will help you, as an instructor, offer learners highly effective learning experiences. Targets provides information and insights about the following:

- Work Keys
- Applied math
- Proficiency outcomes (based on the national mathematics standards)
- Problem solving
- Instructional strategies
- Using practice problems
- Pretesting and post-testing
- Resources for developing additional learning activities and practice problems.

The instructional strategies and practice problems are divided by Work Keys level (i.e., Improving to Levels 3-7).

Overview of the Work Keys System

As explained earlier, the guidelines set forth in the Work Keys System form the structure upon which *Targets for Learning: Applied Mathematics* was developed. Work Keys is a national system for teaching and assessing workplace academic skills in secondary, postsecondary, and adult training programs. It was developed by American College Testing (ACT) to provide educators and employers with a system for measuring the skill levels of employees and students—who are prospective employees. In addition, the Work Keys System gives educators, employers, and learners a common language for understanding and discussing the skills and skill levels that are required to successfully perform specific jobs. The Work Keys System has three components:

- **Profiling** uses job analysis to identify the skills and the skill levels that are needed to succeed in *specific jobs or occupations*.

- **Assessments** measure the *individual's* skill levels. Assessments are developed by ACT and administered by schools and Work Keys satellite centers. In Ohio, all vocational students take three Work Keys assessments at the beginning of their junior year and again at the end of the senior year. In addition, adults in Ohio take Work Keys assessments at adult vocational full-service centers, which serve as the primary Work Keys satellite centers.

- **Instructional support** helps educators and trainers supplement and reinforce their existing curriculum and instruction to address workplace requirements more directly. ACT published *Targets for Instruction* to give educators and trainers guidelines for developing effective interventions for learners who need to improve their skill levels. Those guidelines were used by the authors of the *Targets for Learning* instructional materials.

All of the *Targets for Instruction* books can be purchased through The Ohio State University's Vocational Instructional Materials Laboratory, which is part of the Center on Education and Training for Employment. The sales office can be reached by calling 800/848-4815 or faxing 614/292-1260.

Additional information about Work Keys can be obtained directly from ACT at 800/553-6244.

What is Applied Math?

ACT defines applied math as "the skill of applying mathematical reasoning and problem-solving techniques to work-related problems."[2] The basic math skills needed at work are not different from those encountered in school. However, the problems encountered at work are different than problems traditionally solved in the classroom because they are not organized as clearly as those presented in textbooks. In the workplace, employees often need to collect information and determine the best way to solve problems. For this reason, learners need to be skilled problem solvers—in addition to being able to understand basic math skills.

Applied math is important for all workers, not just those who handle figures directly. When you stop to think about it, almost every job requires the ability to solve math-related problems. Most of them involve one or more of the following applications:[3]

Quantity
Workers often need to determine the number of items sold, produced, or purchased, or to figure totals on a per unit basis.

Money
Working with monetary units is a central part of business and it affects virtually every job. Minimally, all workers need to understand their paychecks. Work-related tasks that involve monetary units include figuring sales, costs, wages, and expenses.

Time
Work-related problems may involve figuring elapsed time or the relationship of time to safety, quality, production, sales, costs, distance, and area. In many of these tasks, workers must be familiar with conversion of time units.

Measurement
Workers often need to calculate distance, area, weight, and volume to solve problems. They also need to be familiar with conversions, as well as the appropriate degree of accuracy needed for different situations.

Proportions and Percentages
Proportions are used in many tasks that require making predictions (e.g., if X is the amount for 50 units, how much is needed for 150 units?). Percentages are used in the workplace to calculate commissions, discounts, taxes, price increases, changes in sales, wage changes, and profit and loss to name only a few!

Averages
Many records in the workplace are expressed in terms of averages (e.g., those involving sales records, production losses, employee turnover, wages, costs, hours worked). These averages become tools in the decision-making process of the business.

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[2] *Targets for Instruction*, Applied Mathematics, p. 16.
[3] *Targets for Instruction*, Applied Mathematics, pp. 17-18.

Combined Applications

Many math-related workplace problems combine two or more applications. For example, workers are often asked the following questions:

- What *quantity* can be produced in a specified *time*?
- What *distance* can be traveled in a particular *time*?
- What is the *average* cost in terms of *money*?
- What is the "*best buy*?" (To perform this business task, workers must make calculations and then compare the results in terms of relative costs and savings.)

Work Keys measures five levels of applied math *complexity*, 3 through 7, with Level 3 being the least complex and Level 7 being the most complex. Although Level 3 is the least complex, it represents a level of applied math skill that is still well above having no skill at all. **Note that these levels have no relationship to traditional school grade levels.**

The applied math levels build on each other, each one incorporating the skills of the preceding levels. Levels of Work Keys problems are determined by two criteria:

- The *type of mathematical operation* (e.g., single step vs. multiple-step operations, conversions within or between systems of measurement) and

- The *form and order* in which the learners are presented with information (e.g., information may or may not be presented in order that it is needed, extraneous information may or may not be included, all information needed to solve a problem may or may not be provided).

The applied math skills required of workers at each Work Keys level are listed on the following pages. This information was summarized from ACT's book, *Targets for Instruction for Applied Mathematics*, which provides more detailed information about each level as well as examples of problems at each level. (*Targets for Learning* users are encouraged to read *Targets for Instruction* to gain additional insights about Work Keys and applied math.) As you can see from the following information about Work Keys, the skills at the lowest level involve using whole numbers and some decimals in basic mathematical operations. As the levels progress, the problems become *more complex*, include *more extraneous information*, and require *more steps* to solve. In addition, they include fractions, decimals, converting units, averaging, calculating volume and area, and ratios.

Level 3 learners can

1. Add, subtract, multiply, and divide using whole numbers. For example, workers may need to calculate the total hours worked or the number of items that have been sold.
2. Add and subtract using negative as well as positive numbers. Workplace problems often require that workers determine change and direction of change.
3. Change a number from one form to another, using whole numbers, fractions, decimals, and percentages. For example, workplace tasks often require that workers change fractions to percentages, percentages to decimals, and minutes to hours.

Characteristics of Level 3 problems

- Stated simply
- Organized in a straightforward manner and contain only the information needed to solve the problem (i.e., there is no extraneous information)
- Deal primarily with quantities, money, time, and measurement
- Unit conversions involve money and one-step time conversions

Level 4 learners can

1. Perform applications described in the previous level.
2. Reorder information and eliminate extraneous information in order to solve a problem.
3. Calculate single-step conversions using English and non-English units of measurement (e.g., feet to inches, centimeters to meters, hours to minutes).
4. Do one or two mathematical operations, such as addition, subtraction, and multiplication on several positive or negative numbers. Division of negative numbers is not included at this level. Workers must perform a logical sequence of steps when solving problems that involve two steps.
5. Calculate averages, simple ratios, proportions, and rates using whole numbers and decimals. Workers often need to calculate averages of sales, production, wages, and costs. In addition, problems related to mixtures and rates require calculation of ratios, proportions, and rates.
6. Add commonly known fractions, decimals, or percentages, and be able to add three fractions that share a common denominator. Many Level 4 problems require workers to perform these operations in their heads.
7. Read a simple diagram or graph to get the information needed to solve a problem.

Characteristics of Level 4 problems

- May involve multiple steps
- Include a small amount of extraneous information
- Information may be presented in a somewhat complex format

Level 5 learners can

1. Perform applications described in the previous levels.
2. Separate the important facts from extraneous information.
3. Look up formulas and use them appropriately to perform one-step unit conversions within or between systems of measurement. The formulas provided in the Work Keys System can be used to make conversions (e.g., pounds to ounces, kilograms to pounds)
4. Calculate using mixed units. For example, workers often need to solve problems that involve calculations such as 5.5′ + 6′11″ or 9.25 hours – 2 hours 30 minutes.
5. Calculate perimeters and areas of basic shapes. Workers need to use the correct formula from those provided in the Work Keys System to find the perimeter and/or area of circles, rectangles, and triangles.
6. Calculate percentage discounts or markups, or complete a balance sheet or order form. Level 4 problems require workers to make these types of multi-step calculations.
7. Calculate the "best buy" using one- or two-step calculations to compare two costs. To do this, workers need to select the information that is needed to make the calculations, perform the calculations, and then compare the results of those calculations.

Characteristics of Level 5 problems

- Often involve money, quantity, and time applications
- Often combine quantity and time applications in rate problems
- Include more extraneous and more complex information than at previous levels, which results in operations and solutions that are less obvious

Level 6 learners can

1. Perform applications described in the previous levels.
2. Solve complicated, multiple-step problems that may require manipulation of the original information. To solve Level 6 problems, workers may need to reorder information, eliminate extraneous information, and perform several-step conversions.
3. Calculate using negative numbers, fractions, ratios, percentages, and mixed numbers. Workers often need to multiply and divide fractions with unlike denominators and find reverse percentages. In addition, ratios may involve conversion of units within one system (e.g., 1 quart = 32 ounces).
4. Calculate multiple rates and then compare the rates or use them to perform other calculations. Level 6 workers often need to solve problems that involve production rates and pricing strategies. These problems might also involve conversions.
5. Find the areas of rectangles and volumes of rectangular solids. This type of workplace problem often requires workers to transpose a formula before making calculations or to use two formulas to change from one unit to another unit within the same system of measurement.
6. Calculate multiple-step problems to determine the "best buy" and use the result in another problem.
7. Find mistakes in calculations. (This is a skill required in workplace troubleshooting.) For example, Level 6 workers should be able to locate mistakes in Level 3-5 problems.

Characteristics of Level 6 problems

- Involve tasks that are more complex in the number of calculations required and in the wording and organization of the problems
- Typically involve proportions, percentages, and averages
- Require the application of measurements to solve problems that involve conversions

Level 7 learners can

1. Perform applications described in the previous levels.
2. Do four or more steps of reasoning and multiple calculations.
3. Solve problems involving more than one unknown and/or nonlinear functions. For example, Level 7 workers may need to combine rates or mixtures.
4. Calculate the percentage of change. Level 7 workers often need to find the percentage of change in quantities (e.g., sales, inventory), measurement (e.g., temperature), and money (e.g., prices).
5. Calculate multiple areas and volumes of spheres, cylinders, and cones. Level 7 workers need to calculate areas and volumes of irregular shapes, which can be determined by breaking them down into regular shapes.
6. Set up and manipulate complex ratios and proportions. They may contain mixed units that require conversions.
7. Determine the best economic value of several alternatives. This often involves the use of graphics or finding a percentage difference or a unit cost.
8. Find mistakes in multiple-step calculations. (This is a skill required in workplace troubleshooting.) For example, Level 7 workers should be able to locate mistakes in Level 3-6 problems.

Characteristics of Level 7 problems

- Include information that is complex, unclearly organized, and may be incomplete
- Require many steps of reasoning

When it comes to helping learners improve their skills with applied math, the most successful instructors are those who understand the differences between problems at different levels and help their learners to do the same. When they understand how problems are leveled, learners and instructors experience the following benefits:

- **Learners can compare their own problem-solving skills with those specified, which helps them set goals and assess their own accomplishments.**
- **Instructors can modify existing materials to fit into the Work Keys leveling system.**

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The following chart summarizes the characteristics of Work Keys applied math problem levels.

Summary of Work Keys Applied Math Levels[4]

Characteristics of applied math problems	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
Amount of extraneous information	none	none	moderate	moderate to high	high
Complexity (e.g., wording, organization)	not complex	slightly complex	moderately complex	moderately to extremely complex	extremely complex
Principles of math that workers are required to apply	basic	basic to moderate	moderate	moderate to difficult	difficult
Number of steps involved in solving the problem	one	one or two	several	several	four or more
The problem requires learners to translate a verbal description to a mathematical problem	minimal	more than Level 3	more than Level 4	more than Level 5	considerable
Formulas are required to solve the problem	no	no	yes	yes	yes
Evaluations or comparisons of solutions are required (e.g., determine the "best buy")	no	no	yes	yes	yes

Now that you understand more about Work Keys and applied math, let's move on to see how you might teach others about solving math-related problems that are encountered in the workplace.

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[4] Adapted from a chart developed by ACT (original source unknown).

Why Should I Teach Applied Math?

Most instructors would agree that the primary purpose of education is to help learners succeed at work, at home, and in their community. And few would argue against the need to be effective in applying mathematical reasoning and problem-solving strategies to work-related problems in order to succeed at work and in other areas of life. In fact, the Secretary's Commission on Achieving Necessary Skills (SCANS) found that effective workers need to productively use all of the following:

- **Resources** (e.g., allocating time, money, materials, space, and staff)
- **Interpersonal skills** (e.g., working in teams, teaching others, serving customers, leading, negotiating, and working well with people from culturally diverse backgrounds)
- **Information** (e.g., acquiring and evaluating data, organizing and maintaining files, interpreting and communicating, and using computers to process information) Systems (e.g., understanding social, organizational, and technological systems; monitoring and correcting performance; designing or improving systems)
- **Technology** (e.g., selecting equipment and tools, applying technology to specific tasks, maintaining and troubleshooting equipment)

In addition, SCANS identifies a three-part foundation of skills and personal qualities needed for solid job performance—

- **Basic skills** (reading, writing, math, speaking, and listening)
- **Thinking skills** (thinking creatively, making decisions, solving problems, and knowing how to learn)
- **Personal qualities** (individual responsibility, self-esteem, sociability, self-management, and integrity)

In addition, there is a great deal of overlap between the SCANS competencies, the national mathematics standards, and the Ohio mathematics proficiency outcomes. (Refer to Appendix D, pp. 339-344 for a list of ninth-grade and twelfth-grade proficiency outcomes.)

When you stop to think about it, by helping learners solve math-related problems in the workplace, instructors are helping them develop and practice many of the skills identified in the SCANS report, national mathematics standards, and state proficiency outcomes. In other words, **by helping learners become more effective at solving mathematical problems in the workplace, instructors are helping them develop the skills needed to become more productive workers.**

What Can I Do to Help Learners Improve in Applied Math?

Remember that applied math is all about *solving math-related problems* in the workplace. Problem-solving strategies are critical to any instruction aimed at improving all levels of applied math skills. By using the materials provided in *Targets for Learning*, you are providing learners with opportunities to develop their applied math skills.

The ideas listed below should help you to provide learners with additional opportunities for improving in applied math:

- **Encourage learners to enhance their basic problem-solving skills.** For example:
  - ✔ Many *commercial games* require players to use problem-solving skills, including deductive reasoning, categorizing, and/or calculating. Some games are listed below to help you get started. Several games on the list may not be available from local retailers. However, suppliers of instructional math materials, such as William Sheridan & Associates, which is listed in the Supplier section of Appendix B, pp. 323-324, should carry them.

    Abalone®
    Backgammon
    Battleship®
    Checkers
    Chess
    Chinese Checkers
    Connect Four®
    Game 24®[5]
    Mastermind®
    Mancala
    Othello®
    Quarto®
    Sequence®
    Shape by Shape®
    Tangoes®
    TriOminoes®

  - ✔ Start several classes a week with a "*brain teaser*." Refer to books such as *Games for the Superintelligent*, *More Games for the Superintelligent*, *Favorite Problems*, and *Super Problems* or game card packs such as Mind Trap®[6] and Visual Brain Storms®[7] for ready-to-use activities. (Information about the books is provided in Appendix B.)

  - ✔ Start several classes a week with a math energizer like the one below.[8]

    1. Pick a number from 1 to 9.
    2. Subtract 5.
    3. Multiply by 3.
    4. Square the number (or multiply the number by the same number).
    5. Add the digits until you have only one (e.g., 64 = 6 + 4 = 10 = 1 + 0 = 1).

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[5] The object is to arrive at the answer of 24 by adding, subtracting, multiplying, or dividing. Sold by Suntex International, this math game has several versions, including single digits, double digits, exponents, fractions, and decimals. Appropriate for classroom use.

[6] Developed for teams, this game includes 500 classic puzzles, conundrums, murder mysteries, and trick questions.

[7] Visual Brain Storms: The Smart Thinking Game® and Visual Brain Storms 2® are distributed by Binary Arts Corporation.

[8] This problem was taken from the Internet (original source unknown).

6. If the number is less than 5, add 5. If it is more than 5, subtract 4.
7. Multiply by 2
8. Subtract 6
9. Map the digit into a letter in the alphabet (i.e., 1 = A, 2 = B, etc.)
10. Pick a name of a country that begins with that letter.
11. Take the second letter in the country name and think of a mammal that begins with that letter.
12. Think of the color of that mammal.
13. Now share the color, name of the mammal, and country it is from with your neighbor.
14. What did you discover? Can you explain what happened?

(Solution: Each learner will have the same answer—an elephant from Denmark.)

- **Have learners perform hands-on activities** through which they solve applied math problems. Note that these activities may require learners to work with one another—in the same way that they would in the workplace. Examples include the following:
  - ✔ Have learners calculate the area of classroom walls or floors to determine the amount carpeting or wallpaper that would be needed to cover the surface. Then have them determine the quantity of materials that should be purchased to complete the job. The activity can be made more complex by having them determine time and cost factors, and calculating the cost per unit.
  - ✔ Have learners design and build something from wood and nails (e.g., a bat house). In addition to calculating dimensions, they should determine the amount of materials needed and calculate construction costs.
  - ✔ Have learners operate a store. They should order materials, keep track of inventory, and calculate costs.
  - ✔ Have learners prepare and distribute a meal for the class. (Chili or soup would be a good choice.) Learners should determine quantities of ingredients needed to prepare each dish, calculate the amount of tableware needed, and figure out the per-person cost of the meal.

- **Have teams of learners participate in problem-based learning (PBL) activities.** PBL gives learners of *all Work Keys* levels opportunities to apply mathematical principles to real-world problems. When solving this type of problem, learners are experiencing the types of problems they will encounter in the workplace. For example, they need to figure out what information, materials, and tools they need. In addition, learners need to communicate with others, both during the problem-solving process and when presenting the final information to a "customer" or a "supervisor." Note that your role as an instructor is to **facilitate learning**—not to tell learners what to do and how to do it. (Refer to pp. 32-33 for suggestions about being a resource for learners, leading discussions, and asking open-ended questions.)

  PBL activities can also help instructors by providing an effective way to assess a learner's ability to apply mathematical principles to real-life situations. For example, an instructor may challenge a group of learners to solve a real-life problem. The instructor might then make and note observations during the problem-solving process and/or may use a rubric to evaluate learner's skills at mathematical problem solving. The problems and rubric provided in Appendix C may be used for this type of evaluation.

  The information provided in Appendix C, pp. 327-338, was written by a team of high school math teachers. As you can see, they span a wide range of real-life application. Feel free to use them with learners in your classes. You may also want to use them to get ideas for developing your own problems.

Gender Equity: What Can I Do?

There's another aspect of teaching and training that instructors need to consider when planning to help learners develop skills related to applied math. Often overlooked in math, science, and technology instruction, **addressing gender equity provides learning opportunities that will help *all* learners succeed**. When it comes to applied math, many females do not have the same types of experiences, both in and out of school, as males. As a result, males and females have traditionally received differing qualities of education—even when they study in the same classroom. Perhaps you are skeptical about this fact—especially if you are male. Please don't stop reading; there are some simple things that you can do to check it out for yourself.

Researchers[*] have found the following inequities in the way teachers interact with male and female students:

- At all levels of education, **female learners receive less teacher attention and less useful teacher feedback**.
    - ✔ Teachers call on female learners less often than they call on male learners.
    - ✔ Teachers ask probing and higher-order thinking questions of female learners less often than they do of male learners.
    - ✔ Teachers often instruct male learners on how to perform tasks but tend to do tasks for female learners.
    - ✔ Teachers tend to give female learners less feedback (e.g., praise, criticism) than they give male learners.
- In class, **female learners talk significantly less than males learners do**.
    - ✔ In elementary and secondary school, female learners are eight times less likely to call out comments. When they do, they are often reminded to raise their hands, while similar behavior by boys is accepted.
    - ✔ Female learners are less likely to raise their hands, because, at some level, they are aware that males get called on more. In addition, they may take longer than males to think about their responses before raising their hands, and they may lack confidence in their ability to answer correctly.
- When working in coed pairs, **males tend to dominate** in math, science, and technology-related activities, resulting in fewer opportunities for females to experience hands-on learning in these curriculum areas.

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[*] Comprehensive research on the topic of gender equity has been done by Myra and David Sadker. Their findings are published in *Failing at Fairness: How America's Schools Cheat Girls* (1994).

- **Female learners rarely see mention of the contributions of women in the curriculum.** Most textbooks continue to present a male-dominated view of the world. For example, textbook illustrations often depict males performing activities while females passively watch and support them.

- **Females experience pressure from their friends to *not* do well** in science, math, and technology-related classes; they may be teased for being "nerdy" or unfeminine if they perform well.

This subconscious inequity has far-reaching consequences. There are clear connections between inequity in instruction and females' avoidance of math. Because females have had fewer opportunities to develop their mathematical skills they may be less confident in their abilities to do math. Therefore, females are often less prepared for, and less likely to choose courses in math, science, and technology. In addition, the research clearly indicates that those females who *do* take upper-level math and science courses are also treated very differently than their male classmates; many stop taking them. **Taking fewer math and science courses has resulted in fewer high-paying occupational options for female workers.**

What can an instructor do to provide both female and male learners with equal chances to succeed in applied math? Here are some ideas, which are based on the research that was summarized on the previous page.

1. The most important thing that you can do, as a male or female instructor, is to **be aware of your subconscious bias** and to accept that virtually everyone has been socialized to have that bias. (If you don't believe that you treat male and female learners differently, ask a colleague to observe you in the classroom or make a videotape of your teaching or training to determine whether or not you provide female learners with less attention and different expectations than you do male learners.)

2. **Show female learners that you have confidence in their abilities to do math and science.** Be sure to ask them challenging questions and then give them the encouragement and support they need to find the answers.

3. Make a conscious effort to **provide female and male learners with equal amounts of attention.** Because providing different amounts of attention to male and female learners involves subconscious habits, it is helpful to bring instructor actions to the conscious level. For example, to make sure that they call on both genders equally, some instructors take beginning steps to change that habit by keeping a tally sheet of how many questions they direct to males and females.

4. **Create an atmosphere that fosters female learners' participation.** Females are generally less confident than males about speaking about math, science, and technology in public; you can encourage females to express themselves by making small changes in your own behavior. For example, when asking questions in coed settings, make a conscious effort to ***wait 5-10 seconds*** before calling on anyone. You'll be surprised at the number of timid hands that go up in those few seconds. Or, if only 1/3 of the learners raise their hands after you ask a question, you might want to say, "Think about it and talk with the person sitting next to you. I'll ask again in a few minutes."

5. **Pay attention to group dynamics.** Who speaks? How often, for how long, and in what order? Who interrupts whom? Since females tend to speak less often and for shorter periods of time, be sure to acknowledge their contributions.

6. **Don't "teach down" to any learner.** Expect equally high performance from males and females, as well as from people of all races and national origins.

7. **Provide female learners with additional instruction or practice, when needed.** For example, most females and some males do not have hands-on experience using tools. When providing instruction that incorporates specific tools and equipment (e.g., gauges, multi-meters), instructors should give the learners who lack this experience with direction concerning their use. By doing this, instructors will be allowing all learners to succeed—regardless of their earlier experiences.

8. **Use a collaborative, cooperative approach to activities** rather than a competitive one. Females are generally socialized to solve problems collaboratively while males are taught to compete with other individuals. By providing learners with some opportunities to work together when solving problems, instructors are allowing females to use skills that they are strong in and are helping males to develop skills needed to collaborate effectively.

9. **Use interactive learning methods.** Ask learners to do some of their work in small groups. Females tend to be more effective when they can share their ideas with other.

10. To prevent males from dominating activities in which they tend to have more skill and experience, **pair females with females and males with males** some of the time.

11. **Foster females' independence**. Hold them accountable when they engage in "learned helpless" behavior. When they say, "I can't do it" before exerting their normal level of effort, find ways to re-engage them in the activity. Show faith in their abilities to do things for themselves.

12. In addition to the actions suggested above, do what you can to **increase female learners' confidence** in their abilities to succeed in math-related activities. By providing an instructional environment that is challenging and supportive, and by showing females that you believe they can succeed, instructors can help females be more confident learners in the areas of math, science, and technology. In addition, instructors can bolster learners' confidence by helping them to have successful experiences solving work-related math problems.

13. Review the research findings that were listed at the beginning of this section. Use the space below to write additional ways in which you might help all learners succeed with *Targets for Learning* activities and problems.

Where Do I Begin?

So you've decided to use *Targets for Learning* as a resource for helping learners develop and/or practice problem-solving skills with math. Next, you wonder, "Where do I begin?" You should begin by **laying the groundwork**. Unfortunately, deciding how to do this is not always easy. Everyone using this book has a unique blend of experience, ideas, resources, learners, and needs. Therefore, instructors who piloted these materials developed a list of different ideas about how you might lay the groundwork for using Targets.

1. **Show learners that you have confidence in their abilities to solve applied math problems**—and that *they* should, too. This may involve *dispelling untrue thoughts* and overgeneralizations that some learners have about themselves and others, including the following:

   "Only smart people are good at math."

   "I'm too dumb to learn this stuff."

   "Girls can't do math."

   In addition, confidence can be built when learners have *a lot of successful practice* with problem-based word problems. This is why it is important to have learners work on learning activities and practice problems that are designated for the appropriate Work Keys level.

2. **Learn about Work Keys applied math skill levels.** By teaching yourself about the levels of skills required to solve increasingly complex problems in the workplace, you will *gain insights into how to help learners gain those skills*. In addition, your knowledge of the Work Keys levels will allow you to adapt existing materials to the Work Keys format. (Refer to pp. 5-12 for additional information about Work Keys and the Work Keys skill levels.)

3. If learners are not skilled at taking multiple-choice tests that involve word problems, **teach them test-taking strategies**. It is important that learners' test scores reflect what they know. If learners are not effective test takers, they will score below their actual applied math levels. (Refer to the Assessment section, pp. 35-40, for additional information.)

4. **Determine each learner's current applied math skill level with a *pretest*.** (Refer to the Assessment section, pp. 35-36, for detailed information.) After the pretest is scored, learners can identify their own applied math level by using the Learner's Test Score Summary Sheet. Instructors can record learners' pretest scores on the Applied Math Summary Sheet. (Blank sheets are provided in Appendix E, pp. 367-368.)

5. **Decide how you will *group* learners and at what skill level(s) you will begin instruction.** When making your decisions, consider the learners' pretest results, your ability to instruct more than one group at a time, and the availability of colleagues, aides, or volunteers. Some options follow.

   - *Work with one level-based group at a time.* For example, begin by working with learners who scored at Below Level 3—helping them to improve to Level 3. Once they have increased their skill levels, work with all learners who originally pretested at Below Level 3 and those who scored at Level 3—helping them improve to Level 4. As they improve their skills at problem solving with math, group them with the learners who scored at Level 4—helping them improve to Level 5. Continue the process until all learners are solving Level 7 problems.

   - *Work with two level-based groups at the same time.* For example, work learners who scored at below Level 3 learners in one group—helping them improve to Level 3 **and** work with learners who scored at Level 5 in another group—helping them improve to Level 6. Once the below Level 3 learners have raised their skill levels, group them with the learners who scored at Level 4 and give them opportunities to solve moderately difficult mathematical problems at Level 5. Once learners who scored at Level 5 have raised their skill levels, group them with the learners who scored at Level 6 and give them opportunities to solve the more complex Level 7 problems.

   - *Work with two multi-level groups at the same time.* For example, combine in one group the learners who scored at below Level 3 with those who scored at Level 3. In addition, combine learners who scored at Levels 4 and 5 in another group. Learners who scored at Level 6 can be assigned projects similar to those described in Appendix C, pp. 327-338.

   - *Work with all learners at the same time*, starting by providing Level 3 instruction to all learners. Continue instruction—moving toward Improving to Level 7 activities and problems. When doing this, have learners work together in a variety of groupings. Additional information about dividing learners into groups is included on p. 27 of this section. (Note: Because many learners are not working at their skill level, this is the **least effective** way to provide instruction in applied math.)

6. **Compare your existing curriculum with the math skills**, which are identified in the Work Keys section, pp. 9-12, **and the proficiency outcomes**, which are listed in Appendix D, pp. 339-344. Look for ***gaps in content*** (e.g., identify mathematical principles that you are not teaching, but should be teaching).

7. Read through the *Targets for Learning* strategies and problems at the level(s) you have chosen. (See number 5 in this list.) **Select one or more skills to begin with**. For example, Improving to Level 3 learners will convert units of measurement, time, and money; Improving to Level 4 learners will calculate averages, ratios, and proportions using whole numbers and decimals.

8. **Look in *Targets for Learning* to find the instructional activities and problems related to the skill(s) you've chosen.** Familiarize yourself with the content and workplace applications involved in the activities and problems.

It is important to understand that using *practice problems* like those in *Targets for Learning* is not enough to prepare learners to solve math-related workplace problems. After all, people learn better by **doing** than they do through paper-and-pencil exercises. Consequently, to ensure that learners gain the mathematical skills needed to solve problems encountered in the workplace—and that they can use those skills to solve authentic problems—instructors need to provide learners with ***hands-on learning experiences***. In many cases, it is most effective if hands-on learning activities are conducted **before** learners solve the problems in *Targets for Learning*.

9. As you plan instruction, **choose *instructional strategies* that will help learners develop effective problem-solving skills**. The following general information will guide you in planning instruction for learners at all levels. In addition, suggestions for level-specific instructional strategies are listed at the beginning of each section of *Targets for Learning* problems.

   - Strengthen each learner's **core math skills**. Nobody can solve applied math problems until they can perform basic mathematical calculations.
   - **Relate** new materials and concepts to skills that learners have already mastered.
   - **Model** problem-solving strategies—explain your rationale for making decisions while solving problems.
   - Provide **frequent and varied hands-on practice**, in an atmosphere that fosters curiosity.
   - Use the strategy of **fading**—gradually withdrawing instructor support to encourage learner independence.
   - Use the strategy of **coaching**—asking specific questions and making suggestions to guide the development of learners' skills.
   - Provide opportunities for learners to **work cooperatively**, e.g., to work individually but share ideas with classmates, to work in assigned pairs, and to work in assigned groups of 3-4 learners.
   - Encourage learners to make **interdisciplinary connections**. There are no subject-area lines drawn in workplace tasks; therefore, instructors should provide learning opportunities that are authentically integrated. For example, you will note that many of the problem-based learning activities in Appendix C involve principles of math, physics, and communications. They require skills in all three areas to be used in order to solve the problem accurately and effectively.
   - Provide opportunities for **learner self-evaluation**. When learners analyze why they were wrong (or right), they learn from their errors (and their successes).
   - When appropriate, **begin with concrete learning activities and move toward the abstract**; begin with familiar activities and move toward the unfamiliar.

- When appropriate, **begin with problems in local settings and move toward global settings**.
- Be sure that learners either **demonstrate their competency** at each Work Keys level or are **remediated**. The applied math skills build on each other—level by level. Learners will not be able to succeed at one level until they posses the prerequisite skills of the previous level.

10. When working with the problems included in *Targets for Learning*, **consider the following suggestions for structuring the instructional environment**:
    - Have learners solve problems individually, then come together as a group to discuss them. Discussions should focus on multiple methods of solution, clarity of work and expression, and understanding any errors that were made. As a class, look at the common errors, expression, and multiple methods of solution.
    - After a problem-solving paper is collected, copy several learner solutions (omitting names) on an overhead transparency or handout. As a class, critique the process used to find a solution, focusing on how understandable and clear each sample is.

NOTE: Be aware that this instructional strategy may be counterproductive in some cases because some learners may be sensitive to having their work critiqued by others. If doing class critiques, it is important to set ground rules for providing *objective* feedback in a way that is sensitive to the feelings of others. You may also wish to ask for permission to use individuals' work for a class activity.

- Give learners a problem that is done incorrectly and have them find mistakes, correct the problem, then explain why the problem can't be done that way.
- Have learners write a paragraph to explain how a problem was solved.
- Have learners work in pairs. Have each learner write a paragraph explaining how the other person solved the problem.
- If you have developed a simple rubric for evaluating problem solving activities, distribute and explain it to learners. This will help them understand what is expected of them in the problem-solving process. (A sample rubric is provided in Appendix C.)
- When working on a multiple-step problem, have one learner do the first step, then pass their work on to the next person. The next learner builds on the work of the previous person to continue the next step, then passes it on to the third, etc.
- When asking learners to work in small groups, hold each learner accountable for explaining how the solutions to problems were determined. Explain that *each* of them should be prepared to explain how a given problem can be solved. By checking with different learners in the group at different times, you can ensure that each learner understands how to solve the problems. For example, you can walk around the room while learners work in groups and determine which learners are weakest. Then, during group discussions, call on those learners. (If

the weaker learners understand how to solve the problems, you can be fairly certain the rest of the group members also understand.) In addition, hold the entire team accountable for *each* member's ability to explain solutions. Thus, more skilled members will be less likely to leave weaker learners behind in the group learning process. Dividing learners into groups requires some thought and planning.

Depending on your goals, the activity, and your learners, it may be appropriate to assign learners to work in pairs or small groups based on the following characteristics:

Learner Group	Example
Similar-ability groups	Level 4 learners work together
Mixed-ability groups	Level 3, 4, and 5 learners work together
Same-gender groups	Females work together, males work together
Mixed-gender groups	Males and females work together
Similar-motivational groups	Highly motivated learners work together; less-motivated learners work together
Mixed-motivational groups	Highly motivated learners work with less-motivated learners

It is important to use different groupings for different learning activities; do not have the same learners work together all of the time. After all, successful workplace problem solving involves working on a variety of problems with different people.

11. Decide how to **organize the teaching-learning process**. For some instructors, it may be appropriate to keep "business as usual." For others, applied math instruction might be an opportunity to make some changes—to organize learners in teams, to solicit input from learners, to ask questions instead of giving answers, etc.

Now that you've considered how to lay the groundwork, read on for specific suggestions on structuring learning activities using *Targets for Learning*.

How Should I Structure Learning Activities?

If you've laid the groundwork by completing the steps described in the preceding "Where Do I Begin?" section, you're on your way. Now you're ready to structure a sequence of learning activities to help your learners develop their applied math problem-solving skills. In doing this, review the following information. Of course, you will need to use your own judgement concerning the *sequences, amounts*, and *types* of practice provided for learners—depending upon their skills, characteristics, and needs.

NOTE: In general, the strategies that effective teachers use to teach math can be used to teach learners to solve math-related problems in the workplace. Those strategies are expanded below to take into account the focus on Work Keys levels and problems that are encountered in the workplace.

1. **Help learners understand *why* it is important to be an effective problem solver with math.** Begin applied math instruction with discussions about how math is used in their lives (at school, home, and work) will help learners understand and accept the relevance of applied math.

2. **Teach learners about the Work Keys levels.** When learners understand how the level of difficulty of applied math problems is determined, they are more likely to:
   - understand their current level of competency
   - identify the skills they must develop in order to solve math-related problems in the workplace
   - be motivated to improve their applied math skills

   (Refer to the overview of Work Keys, pp. 5-12, for further information.)

3. **Make sure learners have prerequisite skills.**
   - Learners need to be familiar with the **terminology** used in solving math-related word problems. Learners also need to be familiar with abbreviations that are commonly used in applied math (e.g., ft, in^2, cm, gal, lb, F).
   - Learners need to know how to **make estimations** and to understand why estimating is an important skill. There are several types of strategies for doing estimation, including rounding, front-end estimation, and clustering. (They are described in more detail in the Improving to Level 3 section on pp. 47-48.) Several activities can help learners develop skills in estimating, including the following:
     - ✓ At the beginning of the class, instruct learners to put away their calculators, quickly show a problem on the overhead, and give them a short time (1 or 2 minutes) to come up with an answer. Emphasize that their answer need only be an estimate, and encourage mental computation. Use this activity as an opener for a week or two.

- ✔ Read a series of grades or other values. Have learners listen only (i.e., they should not write), and then guess the mean. Finally, have learners compute the mean to see how close their estimates were.

- Learners need to know how to **operate a basic (non-programmable) calculator**. It is beyond the scope of this book to provide specific instructions for teaching learners to use a basic calculator. Many math textbooks, especially those for applied and/or integrated math programs, include excellent instructional strategies. In addition, most books that help learners prepare for high school proficiency tests include detailed lessons on using calculators.

- Learners need to employ a wide variety of **problem-solving strategies** when solving applied math problems. These strategies help learners to take *actions* that will cause them to interact with the problem situation. Through interaction, learners gain an understanding of problems and options for solving them. Learners' problem-solving strategies include the following[10]:

  - ✔ Act the problem out
  - ✔ Draw a picture
  - ✔ List all possibilities
  - ✔ Set up a similar situation
  - ✔ Look for a pattern
  - ✔ Work backwards
  - ✔ Make a model
  - ✔ Rewrite the problem information
  - ✔ Guess and check
  - ✔ Restate the problem
  - ✔ Make a table

Instructors can help learners improve their applied math problem-solving skills by having learners explain their thinking in solving specific problems. The discussions can take place in small groups or with the whole class. In other instances, learners might be asked to write up their solutions as if they were to convince someone else to take the appropriate action.

4. **Encourage learners to set their own goals.** Because learners have taken a pretest and have determined their own applied math levels (by completing the Learner's Test Score Summary Sheet, which is described in the Assessment section of this book), they will know the level at which instruction should begin—their current skill level. With this knowledge as a foundation, guide learners in setting their own *goals* and help them keep these goals in mind as they participate in learning activities.
Goals are clearest when learners see the relationship between their goals and specific job qualifications, such as the requirements of a local employer or the Work Keys skill levels described in an occupational profile. The businesses in your community that use Work Keys may be able to provide you with job profiles.

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[10] This list was adapted from *Problem Solving...a basic mathematics goal* (1980), which was written by the Ohio Department of Education as a resource on teaching problem-solving strategies.

5. **Conduct level-appropriate learning activities and give learners practice problems.**

   - **Conduct the learning activities and have learners solve the practice problems from *Targets for Learning*.** Learners should participate in activities that are designed for their applied math level. Specific suggestions are provided at the beginning of the each level's section. In addition, strategies that learners might employ when solving problems are included at the beginning of the section for each Work Keys problem level.

   - **Develop additional learning activities and practice problems using supplemental resources**, as needed. *Targets for Learning* is not meant to be a comprehensive applied math resource. The problems in Targets can give you ideas for other problems that are encountered in the workplace. ***Remember that your primary purpose is to provide learners with work-related problems at the Work Keys level they are working toward.*** (Refer to the description of applied math levels, pp. 9-12, for suggested content at each Work Keys level.) Here are some ideas to get you started:

     - ✔ **Modify work-related problems from existing textbooks** to the Work Keys format. Many of the books written for learners in vocational programs include applied math problems that would be appropriate for use by Work Keys instructors. However, almost none of the problems in standard vocational textbooks include complex problems. Instead of presenting complex problems for learners to solve (i.e., the way problems exist in the workplace), most textbook problems involve single-step problems that are neatly laid out and include no extraneous information. Thus, ***to help learners attain higher Work Keys levels, you will need to make textbook problems more complex and add extraneous information.*** (The Resources section, Appendix B, pp. 311-326, suggests books that contain additional problems and activities.)

     - ✔ **Obtain authentic materials from worksites** (e.g., time sheets, order forms, inventory sheets). Write Work Keys-leveled problems that incorporate these materials.

     - ✔ **Ask learners to bring examples of problems they or others encounter at work.** Have learners work in small groups to determine the Work Keys level of each problem and to solve them.

     - ✔ **Ask a representative from a local worksite to present mathematical information to learners** in the same way they would present it to workers in their business. Have learners work in groups to solve the problems.

     - ✔ **Create projects** that require learners to solve math-related problems. (Refer to the problems in Appendix C, pp. 327-338, for examples.) Although these types of problems are not leveled according to the Work Keys system, they provide learners with opportunities to develop their problem-solving strategies and to learn about new mathematical principles.

Valuable Insights from Targets Instructors

- Be sure to ***provide learners with enough time to practice*** the skills they need to learn. If this is not done, learners will not have enough experience with the skills to result in a long-term change in their skill levels.
- Each Work Keys level builds upon the previous levels. For that reason, ***each level needs to be mastered before advancing to the next level.*** If, after post-testing, you find that some learners are not ready to advance to the next level, provide them with additional instruction at their current level.
- *Allow plenty of time for* ***discussion***—both before and after learning activities. In order to fully understand the mathematical principles and real-world applications, learners need to be able to verbalize what they have learned. They also need time to formulate and ask questions about the topic at hand.

6. During instruction, **facilitate learning** by doing the following:
   - **Be a resource for learners.** By helping learners find answers for themselves and directing them to information sources, facilitators encourage learners to become more autonomous learners—and less reliant on instructors.
   - **Lead discussions** to help learners attain their goals without telling them the answers. By asking learners to share their ideas about how a given problem can be solved, the facilitator encourages them to synthesize their own understanding and share that knowledge with their peers. Instructors might use these questions to enable learners to express their ideas and reactions as follows[11]:
     - ✓ "Are you saying that...?" (Asking about the learner's reasons)
     - ✓ "Why do you think...?" (Asking about the validity of the learner's statements)
     - ✓ "Couldn't it be right that...?" (Asking for supportive evidence)
     - ✓ "How do you know that ...?" (Asking for supportive evidence)
     - ✓ "How might we find out whether...?" (Asking for alternative possibilities)
   - **Ask questions.** Believe it or not, this is one of the most difficult skills for instructors to develop. It takes a great deal of planning and effort to master the skill of questioning. Here are some strategies that many instructors have found helpful.
     - ✓ When conducting a discussion, **prepare several key questions** to get things rolling. This will also serve as a checklist of key points to be addressed.
     - ✓ **Ask open-ended questions**; avoid those that can be answered with "yes" or "no."

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[11] This list was adapted from Matthew Lipman's work, which is cited in *Science With Reason*, pp. 36-37.

- ✔ **Ask questions that require learners to think critically to explain their observations and draw conclusions.** Ask learners to:
  - ➜ synthesize what they have learned (e.g., "What can you generalize about ratios?");
  - ➜ develop predictions based on what they understand to be true (e.g., "What would you predict will happen to payroll costs when employees double their hours on the job?"); and
  - ➜ apply what they have learned to other situations (e.g., "We've shown that conversions are often used in manufacturing. How would retailers use conversions?").
- ✔ Sometimes **answer a learner's question with a question**. This causes learners to think more critically and to solve problems on their own (or with other classmates).
- ✔ After asking an individual or groups of learners a question, **allow 5-10 seconds of wait time** before talking, providing a hint, or calling on someone. This allows all learners to respond—even those who may be unsure of themselves and those who prefer to think answers through before talking about them.
- ✔ **Ask questions without bias**. Refer to the previous section, entitled "Gender Equity: What Can I Do?" for ideas such as those that follow:
  - ➜ Pose the *same number of questions* to both male and female learners
  - ➜ Ask the *same challenging questions* of both male and female learners
  - ➜ *Ask a more difficult, follow-up question* following the answer of either a male or a female learner.

7. **Use various strategies for assessing improvements** in applied math skills that learners have attained. (Refer to the upcoming Assessment section, pp. 35-40, for suggestions.)

8. Plan **additional interventions** for learners whose skills did not improve as much as needed. *It's important to remember this step*. If the way in which you provided instruction didn't "click" for some learners, try a **different approach**. For example, some learners simply cannot comprehend the concepts being taught through paper-and-pencil exercises; however, instructional strategies that allow them to be more active in learning the very same concepts *do* work. The instructional strategies described in the tabbed sections that follow, and the books described in Appendix B, pp. 311-326, should give you many ideas for developing a wide variety of hands-on learning activities.

   In addition, some learners need **more than one hands-on learning experience** before they "get it." Don't worry if you spend more time than you planned to help learners grasp a specific concept or gain a solid foundation at a specific Work Keys level. After all, your goal should be to help the learners in your class to be better problem solvers—not to get through the material.

Assessment

Assessment is important for several reasons, including the following:

- Assessment helps instructors document the gains made by learners.
- Assessment provides learners with information about their current skill level, and helps them take note of their improvements.
- Assessment is a way to document to funders the effectiveness of an intervention program.

The following options are presented to help you determine the most appropriate assessment methods for your learners. Suggestions include pre- and post-testing, recording test scores, helping learners improve their test-taking abilities, and using assessments to check learning and provide feedback.

Assessments To Use Before and After *Targets for Learning* Instruction

It is important to assess the gains made by learners from the time they begin using *Targets for Learning* through the completion of Targets activities. These summative gains are best documented by using a pretest-and-post-test strategy. **Give learners the Work Keys applied math assessment and/or the assessments provided in this book at both the beginning and the end of instruction.**

- The Work Keys assessment, which is administered at all of Ohio's vocational schools and adult full-service centers, is an accurate way for learners and instructors to measure learners' the pre- and post-instructional Work Keys levels. (In most other states, Work keys has service centers in vocational schools and/or community colleges. To locate the service center nearest you, contact ACT directly.)
- Several ready-to-use assessments, which were developed by teams of academic and vocational teachers and industry representatives, are provided in Appendix E, pp. 345-368.

Pretesting and post-testing provides benefits beyond pre- and post-intervention documentation, such as:

- Pre- and post-testing helps learners understand their current skill level.
- Pretesting helps learners set goals for improvement.
- Post-testing helps learners recognize when they've reached their goals.
- Pre- and post-testing helps instructors avoid teaching skills that learners already possess.

Before testing learners, it is important to teach them about effective test-taking strategies. You may wish to provide learners with a handout that covers some or all of the points described on the Math Test Helps and Hints sheet, which follows in this section. It is important to discuss the handout information with learners so that they realize that they control many of the factors related to their testing success.

NOTE: It is important that learners who experience test anxiety receive specific suggestions for dealing with it. Many of the suggestions provided on the Math Test Helps and Hints handout can be used when discussing test anxiety.

After the tests are scored, have learners review their own tests. Have them complete the Learner's Test Score Summary Sheet, which is located in Appendix E, p. 367. By having learners place their test information on this sheet and determine their applied math level, they will see why they placed at a specific level. For many learners, understanding **why** is the first step toward improvement.

In addition, instructors are encouraged to use the test review as an opportunity to help learners understand their current level and the levels above where they scored. By understanding the skills that differentiate one level from the other and seeing where their current skill levels fall, learners can be guided to set goals for improvement.

Record pretest and post-test levels of your learners on one sheet. This allows you to analyze the status of your learners. Some instructors use a separate sheet for each level (e.g., one sheet for all learners with an applied math pretest score of 4). You may wish to use the Applied Math Summary Sheet, which is located in Appendix E, p. 368, to record learners' scores. The same sheet can be used to record learners' accomplishments as they practice applied math.

Assessments That Check Learning and Provide Feedback

Determine what learners know through smaller, formative assessments. The following options may be helpful as you think about ways to document what has been learned about individual topics. Remember, you can record grades and/or observations on the Applied Math Summary Sheet in Appendix E, p. 368.

- **Allow learners to give input on how they will be graded**. By having learners help set grading criteria, the instructor is providing them with opportunities to understand the objectives of the learning activities and to see the connections between what is learned and the way that learning is assessed.

- **Observe learners as they participate in Targets activities**. Jot down notes about the skills learners used and the improvements they have made.

- **Assign one-minute papers**. During the last few minutes of the class, ask learners to do two things: (1) summarize what they learned that day and (2) list any questions that they have about the day's materials. Writing one-minute papers helps learners take responsibility for their own learning, become skilled at synthesizing information, and practice writing. In addition, this is a good instructional strategy for learning whether or not learners have grasped the day's (or lesson's) objectives. Many instructors assign one-minute papers at least once weekly.

- **Assign individual journals** in which learners describe what they did, how it worked, and how they felt about the problem-solving experiences. Such self-reflection helps learners gain insights into how they learn and how they might learn better.

- **Assign self-critiques or reflections**. This is similar to the journal-writing assignment, but is written for a single lesson or problem. Learners provide a written account of what they or she did, how it worked, and how they felt about solving a specific problem. The goal of this assignment is for learners to evaluate their own learning process and consider what they might do differently when solving problems in the future.

- **Assess learners' abilities to solve actual problems**. Sometimes the best way to tell if learners understand a given principle is to have them apply it to an actual problem. Learners can also write a report (or make an oral presentation) that describes the problem, provides a rationale for decisions that were made, and presents options for solving the problems. The problems provided in Appendix C, pp. 327-338, can be used for checking learning.

- **Collect and grade a few of the problems** from *Targets for Learning*. As a check to see if individual learners are able to solve problems in applied math, collect and grade several of the problems. Grading of *all* Targets problems is not recommended because the problems are meant to be a learning tool.rather than an assessment tool.

- Use this space to **write your own ideas** for assessing learners as they learn and practice skills related to mathematical problem solving.

Math Test Helps and Hints

- ✓ *Read the instructions* carefully. Make sure you understand the directions.

- ✓ *Skim* the entire test first.

- ✓ *Budget your time* carefully. (Don't spend so much time on one problem that you don't have time to work on others.)

- ✓ Be sure that you *understand how to take a multiple choice test.* There are four or five answers for each question (A, B, C, D, and sometimes E). Each answer is a possible solution. Often, you can eliminate at least two of the answers through estimating (i.e., doing the calculation in your head). Eliminate answers that you know are wrong by crossing them out. Then you can substitute the remaining solutions into the problem to see which one fits.

- ✓ *Start at the beginning.* Work Keys tests start with easier problems and progress to more difficult ones. It is a competency test, so you must get the beginning problems correct in order to get credit for correct answers to the more difficult problems. For example, you must answer 80% of Level 3 questions before you can be judged competent at that level. You cannot attain Level 4 until you are competent at Level 3 skills.

- ✓ When solving a problem, do the following:
  1. *Read the problem* carefully—**two** times.
  2. Underline the question in the problem. Ask yourself "What am I looking for in this problem?"
  3. *Circle* all the relevant information. Ask yourself "Is this all the information I need to solve the problem?"
  4. *Cross out* (xxxxxxxx) all the unnecessary information. Ask yourself "Is this information needed to solve the problem?"
  5. *Draw a diagram* or picture that represents the words in the problem, if appropriate.
  6. *Choose the correct method* to solve the problem.
  7. *Eliminate* one or more answers that you know are wrong. Cross them out so that you can clearly see the choices that are left.
  8. *Solve the problem* by carefully calculating the answer.

Math Test Helps and Hints, Continued

9. Determine if the answer is reasonable by *checking the answer* in **two** of the following ways:
   - Ask yourself "Does my answer make sense?"
   - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
   - Mentally estimate the answer.
10. When you think you know the answer, reread the question to make certain you have finished the problem. Remember, all of the answers can be obtained through calculation, but only one of them is correct.
11. Once your answer is marked, don't keep changing it—your first answer is usually correct.
    - Refer to the *symbols and formula sheet* when formulas are involved in solving problems.
    - If you have trouble answering a question, try to remember solutions to *similar problems.*
    - If you decide to *skip a question*, mark it so that it will be easy to find when you go back to it.
    - Use the available space in the test book for *scratch paper.*
    - You are not expected to do all of the reasoning and calculations in your head.
    - Take things one at a time, using what you know and *what you are told* in the problem. Often, solving the problem involves combining a series of simple skills.
    - To save time, use your *calculator* when calculations are required. Then check your answer for accuracy by *estimating* the correct answer.
    - Make a *best guess* for problems you can't work out. (There is no penalty for guessing. Do not leave any questions unanswered.) However, guess **only** after you have:
      - → tried your best to answer a question, and
      - → eliminated answers that you know are wrong.
    - *If you begin to feel tense, warm, nervous, and/or anxious,* **stop**! Take three or four deep breaths—inhaling slowly, then exhaling slowly. Then start again on the problem or go to the next one.
    - Research has found that sucking on peppermint hard candies improves test performance. (It's true! Try it!)

Improving to Level 3

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About Level 3 Problems

Level 3 learners can

1. Add, subtract, multiply, and divide using whole numbers. For example, workers may need to calculate the total hours worked or the number of items that have been sold.
2. Add and subtract using negative as well as positive numbers. Workplace problems often require that workers determine change and direction of change.
3. Change a number from one form to another, using whole numbers, fractions, decimals, and percentages. For example, workplace tasks often require that workers change fractions to percentages, percentages to decimals, and minutes to hours.

Characteristics of Level 3 problems

- Problems are stated simply.
- Problems are organized in a straightforward manner and contain only the information needed to solve the problem (i.e., there is no extraneous information).
- Problems deal primarily with quantities, money, time, and measurement.
- Unit conversions involve money and one-step time conversions.

Notes:

Instructional Strategies for Helping Learners Improve to Level 3

Using the practice problems in *Targets for Learning* is not enough to teach learners to solve math-related workplace problems. To ensure that learners gain the mathematical skills needed to solve workplace problems, **instructors need to provide them with opportunities to learn through hands-on experiences**. In most cases, it is important to conduct hands-on learning activities **before** presenting learners with the practice problems in *Targets for Learning*.

Many Below Level 3 learners need to gain an understanding of **basic mathematical principles**. When helping learners improve to Level 3, instructors should provide a wide variety of hands-on activities, like those problems and activities found in the beginning of this section. When introducing a ***new*** skill, instructors should provide as many work-related activities and problems as possible. This will help to show learners that the new skills relate to real-life applications and to skills that they already have, which will help the new material become more meaningful to them.

Furthermore, Below Level 3 learners may not have the **prerequisite skills** needed to succeed at solving work-based problems. As described in the How Should I Structure Learning Activities? section, pp. 29-33, prerequisite skills include familiarity with terminology and abbreviations and the ability to do estimation, operate a basic calculator, and employ problem-solving strategies.

All applied math problems can be double-checked by estimation. The primary ways to make estimations are by rounding, front-end estimation, and clustering. Each strategy is described below:

- **Rounding** is the type of estimation that is most familiar to learners. Rounding can be done at any place value. A number is rounded by following certain rules:
    - ✓ Identify the position of the last digit to be saved.
    - ✓ Increase the digit to be saved by 1 if the digit to the right is 5 or greater. In other words, round a 5 or above up. For example, if the position to be saved is the tens place value, then 46 would be rounded to 50 and 546 would be rounded to 550. Similarly, 89,821 rounded to the nearest thousands place value is 9,000.
    - ✓ Decrease the digit to be saved by 2 if the digit to the right is 4 or less. In other words, round a 4 or below down. For example, if the position to be saved is the tens place value, then 43 would be rounded to 40 and 543 would be rounded to 540. Similarly, 82,821 rounded to the nearest thousands place value is 80,000.
- Another way to do estimation is called **front end estimation**. Using this method, the learner drops all digits after the first digit—regardless of their value. For example, 431 is estimated at 400 and 7,841 is rounded at 8,000.

- Yet another way to do estimation is called **clustering**. Using this method, the learner finds a value that a group of numbers tend to "cluster" around. This method of averaging a group of numbers is especially helpful for speeding up mental computations. For example, when given the numbers 52, 49, 47, 53, 72, 69, and 71, a learner could determine mentally that the numbers cluster around two separate numbers. The first four numbers cluster around 50 and the last three numbers cluster around 70. So, the learner could calculate that (50 x 4) + (70 x 3) = 410 and then divide 410 by the amount of numbers included in the estimate: 410 ÷ 7 = 59.

This section begins with suggested hands-on learning activities and accompanying examples of problems. Furthermore, these exercises can be *modified* to create additional activities and practice problems. Instructors may also wish to use some of the resources listed in Appendix B as a basis for developing other Improving to Level 3 learning activities. In addition, refer to *Targets for Instruction*, pp. 26-37, for specific suggestion in providing instruction to learners who are improving to Level 3.

Suggested Learning Activities

The following learning activities provide the kind of hands-on practice that is needed to help learners improve to Level 3:

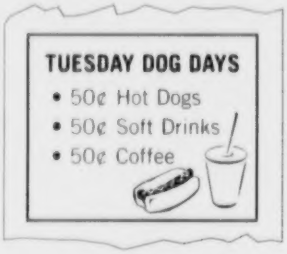
- Have learners use catalogs and sales/grocery ads to total prices for lists of specific items.
- Ask learners to use catalogs and sales/grocery ads to figure the amount of change due to a customer when given a five-, ten-, or twenty-dollar bill.
- Instruct learners to determine the amount of money that would be raised if each member of a group sells an equal number of tickets or other items.
- Create or obtain a job time sheet that lists the hours worked by several employees in a specific time period. Have learners total the hours for each employee. Use some partial hours.
- Have learners use airline schedules to figure the amount of time passengers would spend in the air or between flights.
- Instruct learners to calculate the total mileage for more than one route between two cities, using road maps or an atlas.
- Give learners drawings of a utility meter at two different points in time. Have them figure usage.
- Use catalogs of items such as office supplies to develop exercises involving bulk orders.

Examples of Problems That Can Be Developed As Learning Activities

The problems that follow were developed by the teachers and industry trainers who wrote or piloted *Targets for Learning*. Instructors who are helping learners improve to Level 3 may wish to use these problems with learners in their class. In addition, instructors may wish to develop problems of their own.

At The Ball Game

Use this ad to answer the following questions:



TUESDAY DOG DAYS

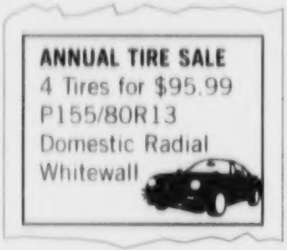
- 50¢ Hot Dogs
- 50¢ Soft Drinks
- 50¢ Coffee

1. You brought $3.00 to the ball game. If you buy a soft drink, how many hot dogs can you buy?

2. If you buy a coffee and 2 soft drinks, how many hot dogs can you buy?

Annual Tire Sale

Use this ad to answer the following questions:



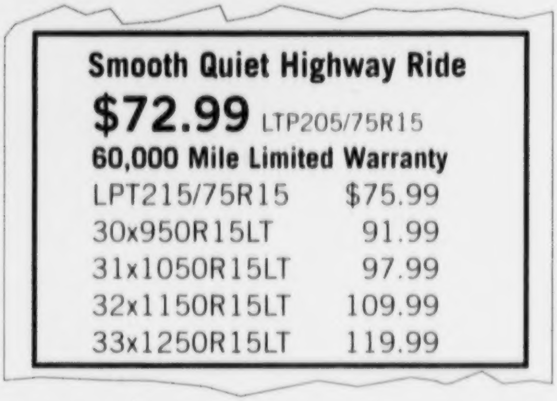
ANNUAL TIRE SALE
4 Tires for $95.99
P155/80R13
Domestic Radial
Whitewall

1. You need a new tire for your vehicle. How much will you pay for one tire (before tax)?

2. You want to purchase a set of new tires, plus a spare. What is your total cost (before tax)?

Whitewall Tire Sale

Use this ad to answer the following questions:



Smooth Quiet Highway Ride

$72.99 LTP205/75R15

60,000 Mile Limited Warranty

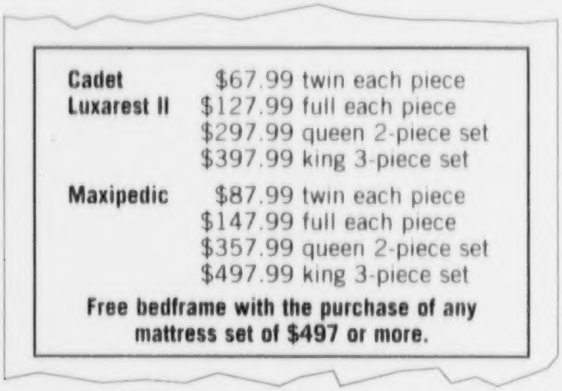
LPT215/75R15	$75.99
30x950R15LT	91.99
31x1050R15LT	97.99
32x1150R15LT	109.99
33x1250R15LT	119.99

1. You need new tires for your car. How much will 4 new tires cost if you buy the 31 x 1050 R15 LT tires?

2. You buy two new tires for your car and two new tires for your truck. If you buy two 20 x 950 R15 LT car tires and two 33 x 1250 R15 LT truck tires, what is your total cost (before tax)?

Mattress Sale

Use this ad to answer the following questions:



Cadet	$67.99	twin each piece
Luxarest II	$127.99	full each piece
	$297.99	queen 2-piece set
	$397.99	king 3-piece set
Maxipedic	$87.99	twin each piece
	$147.99	full each piece
	$357.99	queen 2-piece set
	$497.99	king 3-piece set

Free bedframe with the purchase of any mattress set of $497 or more.

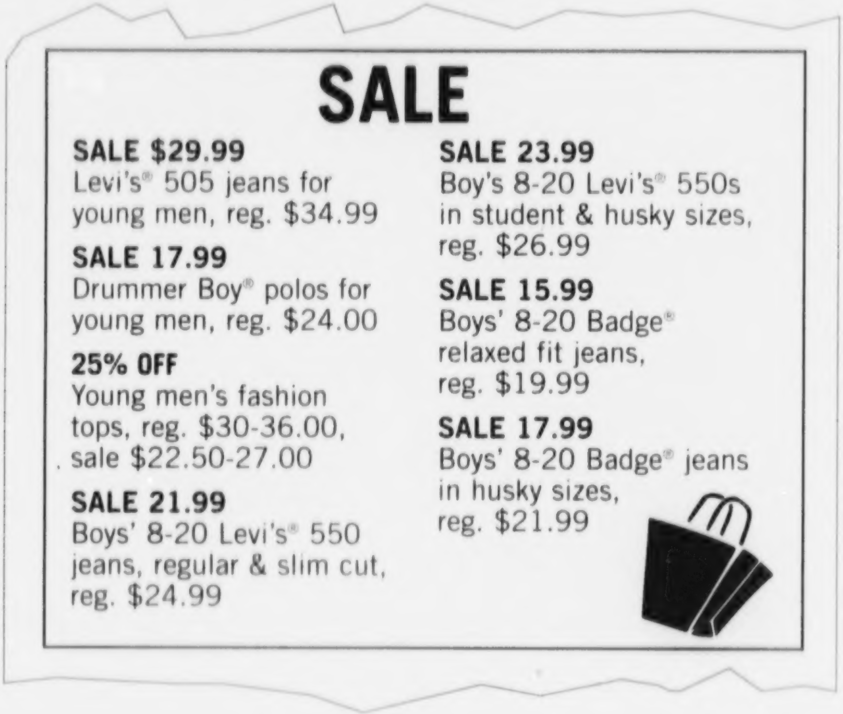
1. If you buy a full-size Cadet mattress and box spring, will you get a free bedframe?

2. If you buy a queen-size Maxipedic mattress set and a Luxarest II twin set, how much will you pay (before tax)?

3. You purchase a Cadet twin mattress. You give the clerk four twenty-dollar bills. How much change should you receive?

Jeans Sale

Use this ad to answer the following questions.



SALE

SALE $29.99
Levi's® 505 jeans for young men, reg. $34.99

SALE 17.99
Drummer Boy® polos for young men, reg. $24.00

25% OFF
Young men's fashion tops, reg. $30-36.00, sale $22.50-27.00

SALE 21.99
Boys' 8-20 Levi's® 550 jeans, regular & slim cut, reg. $24.99

SALE 23.99
Boy's 8-20 Levi's® 550s in student & husky sizes, reg. $26.99

SALE 15.99
Boys' 8-20 Badge® relaxed fit jeans, reg. $19.99

SALE 17.99
Boys' 8-20 Badge® jeans in husky sizes, reg. $21.99

1. You purchase a pair of Levi's® 505 jeans. You give the clerk two twenty-dollar bills. How much change should you receive?

2. You buy a pair of Badge® jeans and a Drummer Boy® polo shirt. What is the total cost of your purchase (before tax)?

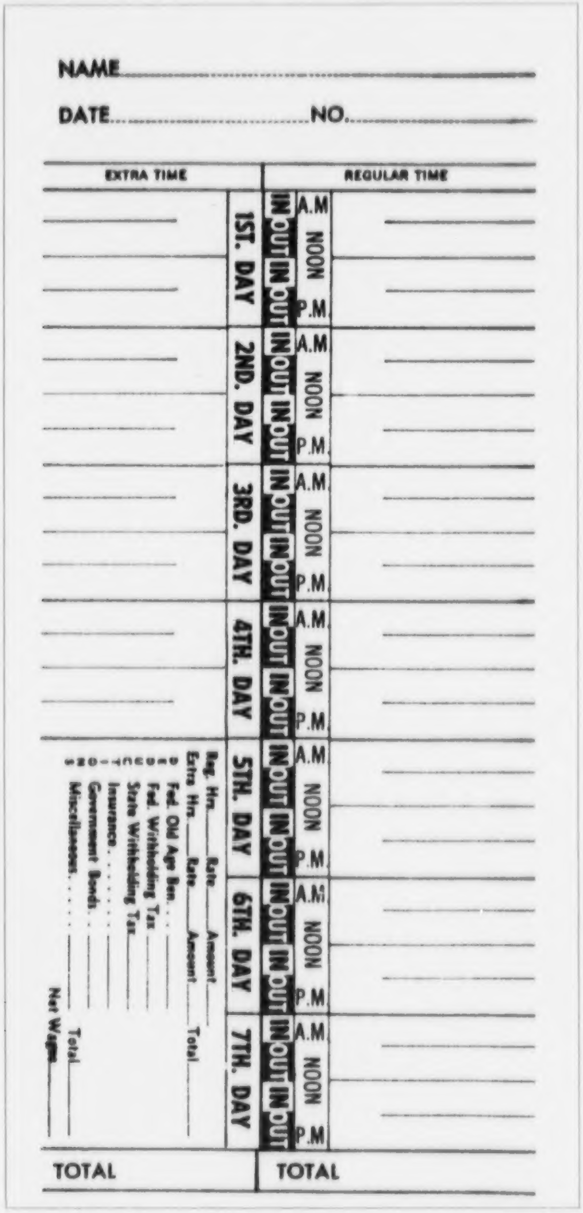
3. You select a $24.00 shirt which is marked 25% off. How much money did you save?

4. How much money will you save by purchasing the Levi's® 550 student jeans instead of the Levi's® 505 jeans?

5. You purchase a pair of Levi's® 505 jeans, a Drummer Boy® polo shirt, and a pair of Badge® relaxed fit jeans. What is the total amount of your purchase (before tax)?

Time Sheets

Use this time sheet to answer the following questions:



NAME

DATE NO.

EXTRA TIME

REGULAR TIME

1ST. DAY

2ND. DAY

3RD. DAY

4TH. DAY

5TH. DAY

6TH. DAY

7TH. DAY

A.M. IN OUT NOON IN OUT P.M.

DEDUCTIONS

Reg. Hrs.___ Rate___ Amount___

Extra Hrs.___ Rate___ Amount___ Total___

Fed. Old Age Ben. . .

Fed. Withholding Tax

State Withholding Tax

Insurance. . . . . .

Government Bonds. .

Miscellaneous. . . . . Total___

Net Wages___

TOTAL

TOTAL

1. Last week, you worked from 8 a.m. to 3 p.m. on Monday, 7:30 a.m. to 1 p.m. on Tuesday, 9 a.m. to noon on Wednesday, 8:30 a.m. to 3 p.m. on Thursday, and 10 a.m. to 2:30 p.m. on Friday. How many hours did you work last week?

2. Give learners several blank time sheets. Have them practice completing them with different hours and calculating the total hours worked.

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Airline Schedule

Use this timetable to answer the following questions:

Freq.	Leave	Arrive	Flight No.	Via/Stops
To Boston, MA				
X6	930a	1122a	US24443	0
	940a	1125	HP969	0
	250p	437p	HP222	0
X6	647p	839p	US1532	0
	740p	922p	HP888	0

You want to take a flight to Boston.

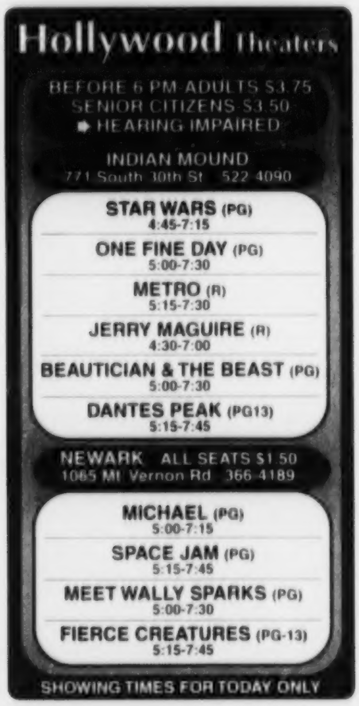
1. If you depart at 9:30 a.m., how long is the flight?

2. How long is the flight that departs at 9:40 a.m.?

3. How long is the flight that departs at 6:47 p.m.?

Movie Schedules

Use this ad to answer the following questions:



Hollywood Theaters

BEFORE 6 PM ADULTS $3.75
SENIOR CITIZENS $3.50
➡ HEARING IMPAIRED

INDIAN MOUND
771 South 30th St 522 4090

STAR WARS (PG)
4:45-7:15

ONE FINE DAY (PG)
5:00-7:30

METRO (R)
5:15-7:30

JERRY MAGUIRE (R)
4:30-7:00

BEAUTICIAN & THE BEAST (PG)
5:00-7:30

DANTES PEAK (PG13)
5:15-7:45

NEWARK ALL SEATS $1.50
1065 Mt Vernon Rd 366 4189

MICHAEL (PG)
5:00-7:15

SPACE JAM (PG)
5:15-7:45

MEET WALLY SPARKS (PG)
5:00-7:30

FIERCE CREATURES (PG-13)
5:15-7:45

SHOWING TIMES FOR TODAY ONLY

BEST COPY AVAILABLE

1. The Star Wars movie is two hours and 15 minutes long. You need to pick up your child from the first showing of Star Wars. What time will you pick up your child?

2. You take your family to see a movie. You purchase two adult tickets and four children's tickets. How much will you have to pay to see Space Jam?

3. You want to see Jerry Macguire. How much will it cost for you and a friend to catch the 4:30 show?

4. You want to see both Michael and Meet Wally Sparks. If you purchase tickets for both movies and give the clerk a five-dollar bill, how much change should you receive?

Ergonomic Task Chair

Use this ad to answer the following questions:

Ergonomic Task Chair

Product No.	Description	Wt. Lbs.	1 Ea.	3+ Ea.
P148-4267	Gray Chair	19	$129.95	$119.99
P148-4268	Black Chair	19	$129.95	$119.99
P148-4269	Burgundy Chair	19	$129.95	$119.99

1. The people in your department want to buy a new chair for the secretary on Secretary's Day. If there are eight people in the department, how much will each of you have to contribute to buy an Ergonomic Task Chair (before tax)?

2. You and two friends decide to buy new desk chairs. If you buy a gray one and your friends buy a burgundy and a black chair, what is the total cost of the three chairs (before tax)?

Ball Point Pens

Use this ad to answer the following questions:

Economical Ball Point Pens

Tough, durable carbide point for smooth writing every time.
Economically priced for the office. Choice of two point sizes.
State color: Black, Blue, or Red. **12 per box.**

Product No.	**Description**	**Weight Lbs.**	**Price Per Box**		
			1	**6**	**12+**
P900091	Fine Point Pen	.2	$1.99	$1.89	$1.79
P900082	Medium Point Pen	.2	$1.99	$1.89	$1.79

1. You need to buy 300 pens for a company promotion. How much will the medium point pens cost?

2. If you buy eight dozen red pens and four dozen blue pens, how many dozen pens are you buying all together? How many single pens are you buying all together?

3. You buy three dozen red, four dozen blue, and six dozen black pens. What is your total cost (before tax)?

4. You need to buy eleven dozen blue pens. How much could you save, per pen, if you buy twelve dozen instead? How much could you save on your total pen order?

Turbocharged Pens

Use this ad to answer the following questions:

Turbocharged Pens

Turbocharged pens that meet the needs of even the most demanding executive. Choice of two point sizes. State color: Black, Blue, or Red. **12 per box.**

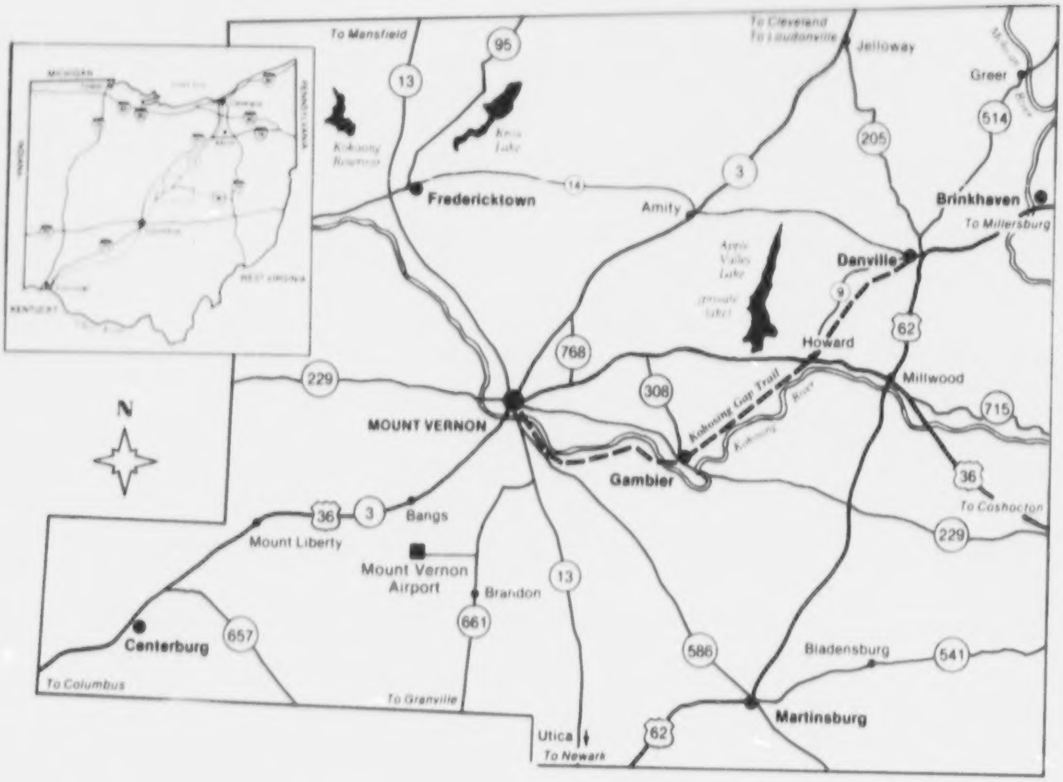
Product No.	**Description**	**Weight Lbs.**	**Price Per Box**		
			1	**3**	**6+**
P900091	Fine Point Pen	.2	$6.69	$6.39	$5.99
P900082	Medium Point Pen	.2	$6.99	$6.39	$5.99

1. You want to buy 100 pens for your department. How much will it cost to buy these pens?

2. You buy a box of red, two boxes of blue, and three boxes of black pens. What is the total cost (before tax)?

Maps

Use this map to answer the following questions:



1. If the scale on the map is ½" equals 25 miles, how far is it from Amity to Danville?

2. If the scale on the map is ¾" equals 50 miles, how far is it from Fredricktown to Mount Vernon?

3. Change the scale and have learners measure distances from various locations.

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Notes:

Practice Problems for Improving to Level 3

Each of the following problems begins with a Learner Page, which presents a problem for learners to solve and, in some cases, guides learners through the problem-solving process. Each Learner Page is followed by an Instructor's Guide, which includes:

- the problem, as stated in the Learner Page
- information needed to solve the problem
- skills needed to solve the problem
- Ohio mathematics proficiency outcomes that pertain to the problem
- one or more methods for solving the problem
- a method for checking the answer through estimation, when appropriate.

Refer to a comprehensive list of suggestions for using these practice problems in the sections titled Where Do I Begin? and How Should I Structure Learning Activities? on pp. 29-33.

Many of the problems do not have multiple-choice answer options. That's because the writers of these problems believe that open-ended answers provide a highly effective learning tool for learners at this level.

In almost all cases, there is more than one way to solve a math problem. The teachers and industry trainers who wrote these problems provided more than one solution method when possible. In addition, learners may discover or explore approaches that are not described in this book. Instructors are encouraged to be open the these different strategies for solving problems.

When solving Improving to Level 3 problems, encourage learners to employ the following strategy:

1. Read the problem carefully **two** times.
2. Underline the question in the problem. Ask yourself, "What am I looking for in this problem?"
3. Circle all the relevant information. Ask yourself, "Is this all the information I need to solve the problem?"
4. Cross out all the unnecessary information. Ask yourself, "Is this information needed to solve the problem?"

5. Draw a diagram or picture to aid in visualizing the problem, if appropriate.

6. Figure out what you need to know to solve the problem.

7. Decide whether to add, subtract, multiply, or divide.

8. Solve the problem by carefully calculating the answer.

9. Check the answer for reasonableness in **two** of the following ways:
   - Ask yourself, "Does my answer make sense?"
   - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
   - Estimate your answer in your head.

Problem 3.1: Jeans

LEARNER PAGE

While shopping for jeans, the pair you chose had a price tag marked $25.99. You gave the clerk $30.00. How much change should you receive? (There is no sales tax.)

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 3.1: Jeans

INSTRUCTOR'S GUIDE

Problem

While shopping for jeans, the you chose had a price tag marked $25.99. You gave the clerk $30.00. How much change should you receive? (There is no sales tax.)

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes	Twelfth-Grade Proficiency Outcomes
1. Compute with whole numbers, fractions, and decimals.	Strand I: Arithmetic 2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

The price of the jeans
The amount of money you gave to the clerk

Skills Needed

Subtraction of whole numbers

Solution Method 1

Subtract the cost of the jeans from the money you have.

$ 30.00	the amount of money you have
- 25.99	subtract the cost of the jeans
$ 4.01	the amount of change received

Solution Method 2

Use rounding to help you solve the problem.

$ 30.00	the amount of money you have
- 26.00	subtract the cost of the jeans, rounded from $25.99 to $26.00
$ 4.00	
+ .01	add the $.01 back to your answer to get the exact answer
$ 4.01	the amount of change you should receive

Estimation

$ 30.00	
- 26.00	(round the $25.99 to $26.00 and subtract)
$ 4.00	(estimated answer)

Answer

$4.01

Notes:

62

Problem 3.2: Odometer Readings

LEARNER PAGE

You took a six-day vacation. The odometer reading when you left home was 26,259 miles. It was 27,507 miles when you returned home. How far did you travel during the vacation?

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 3.2: Odometer Readings

INSTRUCTOR'S GUIDE

Problem

You took a six-day vacation. The odometer reading when you left home was 26,259 miles. It was 27,507 miles when you returned home. How far did you travel during the vacation?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

The odometer reading before the trip
The odometer reading after the trip

Skills Needed

Subtraction of whole numbers

Solution Method 1

$$\begin{array}{r l} 27{,}507 & \text{miles} \\ \underline{-\,26{,}259} & \\ \mathbf{1{,}248} & \text{miles} \end{array}$$

Solution Method 2 (and Estimation)

Estimate the answer by rounding off the mileage figures to 27,500 and 26,300.

27,500 miles
- 26,300
1,200 miles (estimated)

Answer

1,248 miles

Notes:

66

Improving to Level 3

Problem 3.3: Lemonade

LEARNER PAGE

You want to make lemonade for your office picnic. The recipe calls for 3 scoops of lemonade mix to one quart of water. You need to make three quarts. How many scoops of lemonade mix do you need?

DRAWING SPACE:

INFORMATION NEEDED:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 3.3: Lemonade

INSTRUCTOR'S GUIDE

Problem

You want to make lemonade for your office picnic. The recipe calls for 3 scoops of lemonade mix to one quart of water. You need to make three quarts. How many scoops of lemonade mix do you need?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
3. Solve and use proportions.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Number of scoops needed for every quart
Number of quarts needed

Skills Needed

Multiplication and division of whole numbers
Ratio and proportion equation

Solution Method 1

Multiplication: If 3 scoops are needed for 1 quart and you need 3 quarts, multiply 3 scoops times 3 quarts.

3 scoops x 3 quarts = **9 scoops**

Solution Method 2

Draw 3 quart-size containers. Draw 3 scoops for each quart that you have. Count the number of scoops.

Solution Method 3

Consider ratio and proportion as follows:

Use the ratio of 3:1.

$$\frac{\text{scoops}}{\text{quarts}} = \frac{3\text{ scoops}}{1\text{ quart}} = \frac{n\text{ scoops}}{3\text{ quarts}}$$

Cross multiply 3 scoops by 3 quarts: 3 scoops x 3 quarts = 9 scoops per quart

Cross multiply 1 quart by n scoops: 1 quart x n scoops = n scooops per quart

$$\frac{3}{1} \times \frac{n}{3}$$

n = **9 scoops per 3 quarts of water**

Answer

9 scoops of lemonade mix

Notes:

Improving to Level 3

Problem 3.4: Airplane Capacity

LEARNER PAGE

An elevator has a maximum weight capacity of two tons. What is the greatest number of people, each weighing 180 pounds, that can ride the elevator without exceeding the maximum capacity?

A. 21 passengers
B. 22 passengers
C. 22.22 passengers
D. 22.4 passengers
E. 23 passengers

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 3.4: Airplane Capacity

Problem

An elevator has a maximum weight capacity of two tons. What is the greatest number of people, each weighing 180 pounds, that can ride the elevator without exceeding the maximum capacity?

A. 21 passengers
B. 22 passengers
C. 22.22 passengers
D. 22.4 passengers
E. 23 passengers

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
3. Solve and use proportions.
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Number of pounds in a ton
Total weight allowed in the elevator
Weight of one person

Skills Needed

Multiplication of whole numbers
Ratio and proportion equation
Division of whole numbers
Rounding

Solution Method 1

Change tons to pounds.
Divide by the weight of one person.

$$\begin{array}{rcr} 1 \text{ ton} & = & 2{,}000 \text{ lb} \\ \times\, 2 & & \times\quad 2 \\ \hline 2 \text{ tons} & = & 4{,}000 \text{ lb} \end{array}$$

$4{,}000 \div 180 = 22.22$

Round to the next lower whole number, which is **22**. (Even though 22.22 is mathematically correct, the question asks how many people can ride the elevator. The number of people needs to be expressed in whole numbers.)

Solution Method 2

Determine the number of pounds in a ton.
Use ratio and proportions as follows:

$$\frac{\text{tons}}{\text{pounds}} = \frac{1}{2000} = \frac{2}{n}$$

Cross multiply to find that $n = 4{,}000$.

$4{,}000 \div 180 = 22.22$

Round to the next lower whole number, which is 22. (Even though 22.22 is mathematically correct, the question asks how many people can ride the elevator. The number of people needs to be expressed in whole numbers.)

Estimation

Multiply each answer choice by 2,000.

Answer

22 passengers

Notes:

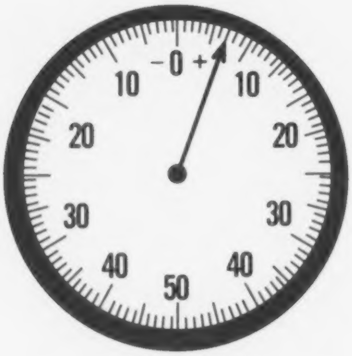
Improving to Level 3

Problem 3.5: Dial Indicators

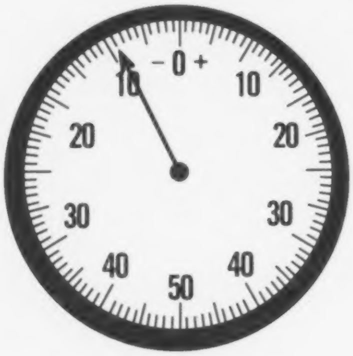
LEARNER PAGE

The measurement on Dial Indicator A is +.007. The measurement on Dial Indicator B is −.009. How much variation is there between the two readings?

A. −.002
B. .002
C. .007
D. .009
E. .016



A



B

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 3.5: Dial Indicators

INSTRUCTOR'S GUIDE

Problem

The measurement on Dial Indicator A is +.007. The measurement on Dial Indicator B is −.009. How much variation is there between the two readings?

A. −.002
B. .002
C. .007
D. .009
E. .016

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
8. Read the scale on a measurement device to the nearest mark and make interpolations where appropriate.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.
Strand II: Measurement
4. Estimate and use measurements.

Information Needed

Reading from the first measurement
Reading from the second measurement

Skills Needed

Reading gauges
Subtraction of positive and negative numbers

Solution Method 1

Subtract the amount of the second measure from the amount of the first measure.

$$\begin{array}{rcr} +\ .007 & = & .007 \\ \underline{-\ .009} & = & \underline{+\ .009} \\ \mathbf{.016} & & \mathbf{.016} \end{array}$$

Solution Method 2

Use a gauge to count off the numbers.

Solution Method 3

Draw a number line (ranging from –.009 to .007) to show the change in the numbers.

Answer

.016

Problem 3.6: Work Hours

LEARNER PAGE

You work from 7:30 a.m. until 4 p.m. Monday through Thursday. You can only work a total of 40 hours for the week. How many hours can you work on Friday?

INFORMATION NEEDED:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 3.6: Work Hours

INSTRUCTOR'S GUIDE

Problem

You work from 7:30 a.m. until 4 p.m. Monday through Thursday. You can only work a total of 40 hours for the week. How many hours can you work on Friday?

NOTE TO THE INSTRUCTOR: You can modify this problem to Level 4 by stating that the work day ends at 4:30 and that a half hour is taken for lunch each day.

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes	Twelfth-Grade Proficiency Outcomes
1. Compute with whole numbers, fractions, and decimals.	Strand I: Arithmetic
	2. Estimate answers, compute, and solve problems involving real numbers.
	Strand IV: Algebra/Functions
	8. Translate verbal statements into symbolic language.

Information Needed

Number of hours worked each day
Number of hours worked from Monday through Thursday
Total number of hours allowed

Skills Needed

Reading a clock
Figuring time
Multiplication of fractions
Subtraction of whole numbers

Solution Method 1

Determine the number of hours worked per day.

7:30 a.m. to 12:00 p.m. = 4 ½ hours
12:00 p.m. to 4:00 p.m. = 4 hours
8 ½ hours worked per day

Multiply the number of hours per day times the number of days.

$8 \frac{1}{2} \text{ x } 4 = {}^{17}/_{2} \text{ x } {}^{4}/_{1} = {}^{68}/_{2} = 34$

Subtract the number of hours worked from the total number of hours allowed.

$$\begin{array}{r} 40 \\ -\ 34 \\ \hline \end{array}$$

6 hours = the number of hours you can work on Friday

Solution Method 2

Draw a clock. Count each hour from 7:00 to 4:00 and subtract ½ hour to find the number of hours worked per day **(8 ½)**

Multiply the number of hours per day by 4 (Monday through Thursday) (8.5 x 4 = **34**).

Subtract the number of hours worked Monday through Thursday (34) from the 40 hours that you can work. This gives you the number of hours you can work on Friday (**6**).

Answer

6 hours

Notes:

Problem 3.7: Sales Tax

LEARNER PAGE

You purchase a new car for $10,000.00. The sales tax rate is 6%. How much tax do you have to pay?

A. $60.00
B. $400.00
C. $600.00
D. $4,000.00
E. $6,000.00

INFORMATION NEEDED:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 3.7: Sales Tax

INSTRUCTOR'S GUIDE

Problem

You purchase a new car for $10,000.00. The sales tax rate is 6%. How much tax do you have to pay?

A. $60.00
B. $400.00
C. $600.00
D. $4,000.00
E. $6,000.00

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes	Twelfth-Grade Proficiency Outcomes
1. Compute with whole numbers, fractions, and decimals. 5. Solve problems and make applications involving percentages. 7. Convert, compare, and compute with common units of measurement within the same measurement system.	Strand I: Arithmetic 2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Price of the new car
Rate of sales tax
How to change a percentage to a decimal
How to multiply using a decimal

Skills Needed

Multiplication with decimals
Converting a percent to a decimal

Solution Method 1

Multiply the price of the car by the rate of sales tax—paying close attention to place value.

$$\begin{array}{r} \$\ 10{,}000.00 \\ \times \qquad .06 \\ \hline 600.0000 \end{array}$$

600.0000, which is **$600.00**

Solution Method 2

$$\frac{\%}{100} = \frac{\text{Part}}{\text{Whole}}$$

$$\frac{6}{100} = \frac{?}{10{,}000}$$

Cross multiply and divide

$6 \times 10{,}000 = 60{,}000$

$$100 \overset{\mathbf{600}}{\overline{)\,60{,}000}}$$

Solution Method 3

.06 on every	1.00
.60 on every	10.00
6.00 on every	100.00
60.00 on every	1000.00
600.00 on every	10,000.00

OR

10% of $10,000	=	$1,000.00
½ of 10%	=	$500.00
1% of $10,000	=	$100.00
5% + 1%	=	6%
$500 + $100	=	**$600.00**

Answer

$600.00

Notes:

Improving to Level 3

Problem 3.8: Pieces of Metal

LEARNER PAGE

You have several pieces of sheet metal left over from a job. The pieces measure ½ yd, ⅔ yd, ¾ yd, and ⅗ yd. How would you arrange these pieces in order from longest to the shortest for storage?

DRAWING SPACE:

(Make sure all needed information is included in your drawing.)

INFORMATION NEEDED:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 3.8: Pieces of Metal

INSTRUCTOR'S GUIDE

Problem

You have several pieces of sheet metal left over from a job. The pieces measure 1/2 yd, 2/3 yd, 3/4 yd, and 3/5 yd. How would you arrange these pieces in order from longest to the shortest for storage?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
7. Convert, compare, and compute with common units of measurement within the same measurement system.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Lengths of each piece of sheet metal

Skills Needed

Changing to least common denominator
Converting fractions to decimals
Converting yards to inches

Solution Method 1

Change each fraction to a decimal.

$^{1}/_{2} = 1 \div 2 = .50$

$^{2}/_{3} = 2 \div 3 = .666$

$^{3}/_{4} = 3 \div 4 = .75$

$^{3}/_{5} = 3 \div 5 = .60$

Arrange in order from the longest to the shortest.

.75 .666 .60 .50

Solution Method 2

Change fractions using the least common denominator.

$\frac{1}{2} = \frac{30}{60}$ (multiply both by 30)

$\frac{2}{3} = \frac{40}{60}$ (multiply both by 20)

$\frac{3}{5} = \frac{36}{60}$ (multiply both by 12)

$\frac{3}{4} = \frac{45}{60}$ (multiply both by 15)

Arrange the fractions in order from the longest to the shortest.

$\frac{45}{60} \quad \frac{40}{60} \quad \frac{36}{60} \quad \frac{30}{60}$

Reduce the fractions.

$\frac{3}{4} \quad \frac{2}{3} \quad \frac{3}{5} \quad \frac{1}{2}$

Solution Method 3

Convert yards to inches.

$$\frac{1}{2} \times \frac{12}{1} = \frac{12}{2} = 6 \text{ in}$$

$$\frac{2}{3} \times \frac{12}{1} = \frac{24}{3} = 8 \text{ in}$$

$$\frac{3}{4} \times \frac{12}{1} = \frac{36}{4} = 9 \text{ in}$$

$$\frac{3}{5} \times \frac{12}{1} = \frac{36}{5} = 7\,{}^{1}\!/_{5} \text{ in}$$

Arrange the fractions in order from longest to shortest.

$^3/_4$ $^2/_3$ $^3/_5$ $^1/_2$

Answer

$^3/_4$ $^2/_3$ $^3/_5$ $^1/_2$

[illegible]

MATHEMATICS

TARGETS FOR LEARNING

% = π

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About Level 4 Problems

Level 4 learners can

1. Perform applications described in the previous level.
2. Reorder information and eliminate extraneous information in order to solve a problem.
3. Calculate single-step conversions using English and non-English units of measurement (e.g., feet to inches, centimeters to meters, hours to minutes).
4. Do one or two mathematical operations, such as addition, subtraction, and multiplication on several positive or negative numbers. (Division of negative numbers is not included at this level.) Workers must perform a logical sequence of steps when solving problems that involve two steps.
5. Calculate averages, simple ratios, proportions, and rates using whole numbers and decimals. Workers often need to calculate averages of sales, production, wages, and costs. In addition, problems related to mixtures and rates require calculation of ratios, proportions, and rates.
6. Add commonly known fractions, decimals, or percentages. Add three fractions that share a common denominator. Many Improving to Level 4 problems require workers to perform these operations in their heads, mirroring workplace requirements.
7. Read a simple diagram or graph, then extract the information needed to solve a problem.

Characteristics of Level 4 problems

- Problems may involve multiple steps.
- Problems include a small amount of extraneous information.
- Information may be presented in a somewhat complex format.

Notes:

Instructional Strategies for Helping Learners Improve to Level 4

When introducing a new skill, give learners as many work-related activities and problems as possible. Completing these activities will help learners to recognize that the new skills relate to real-world applications and to the skills they already have. Thus, by helping learners make real-life connections, the new material will have more meaning to them. Using the practice problems in *Targets for Learning* is not enough to teach learners to solve math-related workplace problems. Instructors need to provide learners with a wide variety of **hands-on learning experiences**. In most cases, it is important to conduct such activities **before** presenting learners with the practice problems in *Targets for Learning*.

When developing Improving to Level 4 problems, remember to include multiple-step operations. In addition, remember that having learners "talk out" and/or role play the situation outlined in workplace problems can provide stronger learning than paper-and-pencil problem solving.

This section begins with suggested learning activities. Instructors may also wish to use some of the resources listed in Appendix B as a basis for developing other learning opportunities for Level 4 learners. In addition, refer to *Targets for Instruction*, pp. 38-47, for specific suggestion in providing instruction to Level 4 learners.

Suggested Learning Activities

Making Orders

Using prices from catalogs or ads, have learners calculate totals and then a percent tax or discount. Have them complete order forms with several items, shipping charges, and tax. Both activities allow the learner to practice multi-step problems.

Instructors may wish to create word problems using ads taken from different types of catalogs. To make problems relevant to learners' interests, use catalogs that contain items related to learners' occupations or interests (e.g., auto parts, lumber store supplies).

Here are some examples of real-life problems that involve the use of catalogs. They may be assigned for in-class use or as homework.

- You have $250 from your birthday presents to spend on work clothes. What can you buy including shipping, tax, and other costs? Come as close to $250 as you can without exceeding it.

- You just won $1,000 in the lottery and need to spend all of it furnishing the new apartment you just rented. Since you have never lived on your own before, you need everything. What will you buy?

- You are going camping this weekend and need all necessary supplies. Fortunately, the local sporting store is holding a storewide sale-15% off of everything! What essentials can you buy without spending more than $300?
- You are going to have a baby! What can you buy at the local Meijer store with the $100 gift certificate you just received from your co-workers?
- Using ingredients needed to change the oil in your car, compare the cost of an at-home oil change with the $19.95 special at the local Quick Oil Change. Which saves you money? How much and why?
- Using ads from the local newspaper, shop for groceries. Decide what you would need to purchase to feed a family of four for one day (all three meals). Total the cost of the items you selected. Then determine the cost of each servingper meal. Which meal is the cheapest to eat at home? How does this compare to eating out three meals at local restaurants? (Calculate the cost of eating out in the same way you calculated three meals from the grocery store. Then compare the two eating options.)

Analyzing Data Presented in Charts and Graphs

Charts and graphs are used in the workplace in many ways. Instructors should give learners a wide variety of learning experiences that use charts and graphs, including the following.

Have learners figure **averages** based on graphs and diagrams from print media (e.g., newspapers, magazines, sales reports, annual reports). One way to do this is to bring a stack of old magazines and newspapers to class. Have each learner develop bar graphs, pie charts, tables and charts that are based on the information found in them. Also, have them calculate the averages and place items in descending and/or ascending orders. Examples include:

- Weather forecasts vs. actual weather temperatures
- Sports scores
- Topics covered in the "Dear Abby" column for one month
- Front page news stories, comparing foreign vs. domestic news
- Total the photos of men, women, and children. Compare the three.

Enhance the learning by asking learners to share and describe their findings with the class.

Fractions

Use one or more of the following activities help learners practice using fractions:

- Double recipes or other mixtures which use fractional amounts.
- Use cardboard pizzas for learning activities. (Pizza Hut fraction kits can be ordered from Howard's Office Supplies, Columbus, OH, 614/228-1200; approximately $18.00/set.) Have learners find as many whole pizzas as possible from the slices of pizza provided. Instruct them to write out the equations in fractions each time and add them on paper. Also ask them to convert each slice to decimals and use a calculator to check their work.
- Working with the stock market section of the newspaper, teach learners to simulate stock purchases by starting with a set amount (e.g., $1,000), selecting their favorite stocks, then following their monitoring price changes.
- Using a simulated checkbook register with several entries, have learners calculate the balance. Be sure to include overdraft situations to help learners grasp the concept of negative numbers.
- Conduct an activity similar to the checkbook exercise above using inventory sheets containing actual production supplies with reorder points.
- Give learners data on miles driven and gas used for each of several cars or trucks. Have them calculate the miles per gallon for each car. Having completed this part of the exercise, learners can calculate the average rate for the fleet. In addition, learners could be given the mileage rate and asked to calculate the amount of gas needed for a 1,500 mile trip.
- Using a road map, have learners make conversions on the scale. The mileage provided in road atlases and map books could provide some of the information needed to solve mileage conversion problems.
- Using distance and average speed, ask learners to determine the time required for a specific trip.
- Have learners use proportions to calculate mixture amounts using the instructions on containers of lawn fertilizer, caulking compound, or similar products.
- Instruct learners to use proportions for creating scale drawings of the classroom or parking lot, stressing the accuracy of the scale.
- Have learners check different mechanical parts against blueprints and record any size discrepancies.

- Have learners measure several different items using calipers, scales, and/or dial indicators. Ask them to record all the measurements, put them in ascending or descending order, and find the average measurement for all parts.

- Install thermometers in classroom so that learners can take daily readings to create a chart of weather for the month. At the end of the month, have them find the low, high and average temperatures

- Have learners use efficiency production sheets to calculate downtime, machine speed, hourly production, and similar actual workplace measurements. (See the sample efficiency production sheet on the following page.)

- Teach learners to use data recording worksheets to work through word problems. Have them work individually and then compare answers with each other.

Glass Department Efficiency Production Sheet

Learners should do the following:

- Calculate averages
- Graph the charts
- Find the percentage of rejects over good pieces
- Find the total of each column

Part: Glassware

Machine #2

Dates:	Supervisor	Operator	Total Hours	Hours Down	Speed of Machine	Pieces That Are Good
1/18-2nd	Mack	Long	4.00	2.00	364	713
1/19 -1st	Smith	Marcus	12.00	0.00	364	4234
1/19 -2nd	Mack	Long	12.00	1.25	364	3570
1/20 -1st	Lewis	Marcus	12.00	0.00	393	4355
1/20 -2nd	Null	Long	12.00	0.00	393	4522
1/21-1st	Lewis	Mallory	12.00	0.00	393	4596
1/21 -2nd	Null	Babcock	12.00	0.50	393	4446
1/22-1st	Lewis	Dixon	12.00	0.00	393	4572
1/22 -2nd	Null	Babcock	12.00	0.00	393	4467
1/23 -1st	Smith	Dixon	12.00	0.00	393	4489
1/23 -2nd	Mack	Babcock	12.00	0.00	393	4712
1/24-1st	Smith	Marcus	12.00	0.00	393	4539
1/24-2nd	Mack	Long	12.00	0.00	393	4596
1/25-1st	Smith	Marcus	12.00	0.00	393	4362
1/25-2nd	Mack	Long	12.00	0.00	410	4761
1/26-1st	Lewis	Marcus	12.00	0.00	400	4110
1/26-2nd	Null	Long	12.00	0.00	393	4101
1/27-1st	Lewis	Dixon	9.00	0.50	393	2938

Notes:

Practice Problems for Improving to Level 4

Each of the following practice problems begins with a Learner Page, which presents a problem for learners to solve and, in some cases, guides learners through the problem-solving process. Each Learner Page is followed by an Instructor's Guide, which includes:

- the problem, as stated in the Learner Page
- information needed to solve the problem
- skills needed to solve the problem
- Ohio mathematics proficiency outcomes that pertain to the problem
- one or more methods for solving the problem
- a method for checking the answer through estimation, when appropriate

Refer to a comprehensive list of suggestions for using these practice problems in the sections titled Where Do I Begin? and How Should I Structure Learning Activities? on pp. 23-33.

Some of the problems do not have multiple-choice answer options. This is because the writers of these problems believe that open-ended answers provide a highly effective learning tool for learners at this level.

In almost all cases, there is more than one way to solve a math problem. The teachers and industry trainers who wrote these problems provided more than one solution method when appropriate. In addition, learners may discover or explore approaches that are not described in this book. Instructors are encouraged to be open the these different strategies for solving problems.

When solving Improving to Level 4 problems, encourage learners to employ the following strategy:

1. Read the problem carefully two times.

2. Underline the question in the problem. Ask yourself, "What am I looking for in this problem?"

3. Circle all the relevant information. Ask yourself, "Is this all the information I need to solve the problem?"

4. Cross out all the unnecessary information. Ask yourself, "Is this information needed to solve the problem?"

5. Draw a diagram or picture to aid in visualizing the problem, if appropriate.

6. Decide which steps to perform and the order in which to perform them. Solve the problem by carefully calculating the answer.

7. Check to be sure that you answered the question that was asked.

8. Check the answer in two of the following ways to see if it is reasonable.
    - Ask yourself, "Does my answer make sense?"
    - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
    - Make a mental estimation.

Problem 4.1: CD Order

LEARNER PAGE

You work in a retail music store. One of your job responsibilities is ordering CDs. In order to keep the most popular CDs in stock, you must place an order on the day the inventory falls below 50 CDs. At closing on Sunday, there were 135 CDs in stock. Anticipated sales of the CDs for Monday are 25; Tuesday, 35; Wednesday, 50; Thursday, 15; and Friday, 75.

On what day should you reorder CDs?

Underline the **INFORMATION NEEDED** in the problem above. List it here if you wish.

SOLVE:

CHECK your work with estimation. Is your answer reasonable?

Problem 4.1: CD Order

INSTRUCTOR'S GUIDE

Problem

You work in a retail music store. One of your job responsibilities is ordering CDs. In order to keep a popular CD in stock, you must place an order on the day the inventory falls below 50 CDs. At closing on Sunday, there were 135 CDs in stock. Anticipated sales of the CDs for Monday are 25; Tuesday, 35; Wednesday, 50; Thursday, 15; and Friday, 75. On what day should you order CDs?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Current inventory and reorder day
Anticipated sales each day of the week

Skills Needed

Addition
Subtraction

Solution Method 1

Layout the problem in graph format to show the following:

Day	Stock Level	Anticipated Sales	Reorder?
Sunday	135		
Monday	110	25	
Tuesday	75	35	
Wednesday	45	30	yes

Solution Method 2

135	CDs on Sunday
–25	CDs sold on Monday
110	CDs left on Monday
–35	CDs sold on Tuesday
75	CDs left on Tuesday
–50	CDs sold on Wednesday
25	CDs left on **Wednesday**—time to reorder!

Solution Method 3

Current stock level is	135
Reorder point is less than 50	– 49
Actual sales	86

Monday:	25
Tuesday:	35
Wednesday:	30
Total sales:	90

Suggestion: Another method of graphing is to have learners use a calendar, showing sales by the day of the week on the calendar.

Answer

Wednesday

Notes:

Problem 4.2: Catered Breakfast

LEARNER PAGE

You work in an office with 24 other employees. Once a week your employer orders a catered breakfast. Each employee pays equal share of breakfast cost. Goodies Inc. charges $25.00 to deliver and $2.75 per person. Your employer might change to Yummies America. They charge $33.00 to deliver and $2.20 per person.

If your employer changes caterers, how much will you save?

A. $ .32
B. $ .77
C. $ .23
D. $1.23

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 4.2 Catered Breakfast

INSTRUCTOR'S GUIDE

Problem

You work in an office with 24 other employees. Once a week your employer orders a catered breakfast. Each employee pays equal share of breakfast cost. Goodies Inc. charges $25.00 to deliver and $2.75 per person. Your employer might change to Yummies America. They charge $33.00 to deliver and $2.20 per person.

A. $ .32
B. $ .77
C. $ .23
D. $1.23

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Different caterers and their delivery and per person charge.

Skills Needed

Ability to read and locate information in a problem
Multiplication, addition, subtraction and division
Ability to construct and apply an algebraic equation format

Solution Method 1

Goodies Inc. charges per person: $2.75 + ($25.00 ÷ 25 people) = $3.75/person
Yummies America charges per person: $2.20 + ($33.00 ÷ 25 people) = $3.52/person

Savings: $3.75
− 3.52
$ .23 savings if Yummies America caters

Solution Method 2

$ 2.75
− 2.20
$ .55 savings if Yummies is chosen

delivery cost differences are $33.00
− 25.00
$ 8.00 additional cost

$ 8.00 additional cost divided by 25 employees equals $.32 per person added

$ .55 savings
−.32 added cost
$.23 savings with Yummies

Solution Method 3

Goodies Inc. = ($2.75/person x 25 people) + $25.00 delivery = $93.75

Yummies America = ($2.20/person x 25 people) + $33.00 delivery = $88.00

$ 93.75
88.00
$ 5.75

$ 5.75/25 people = **$ .23 savings**

Answer

$ .23

Notes:

Problem 4.3: Bedroom Carpet

LEARNER PAGE

You want to carpet a bedroom measuring 16 ft by 20 ft. How much carpet must you purchase?

A. 36 sq yd
B. 320 ft
C. 72 ft
D. 72 sq ft
E. 40,000 sq in

Underline the **INFORMATION NEEDED** in the above problem.

DRAWING SPACE:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.3: Bedroom Carpet

INSTRUCTOR'S GUIDE

Problem

You want to carpet a bedroom measuring 16 ft by 20 ft. How much carpet must you purchase?

A. 36 sq yd
B. 320 ft
C. 72 ft
D. 72 sq ft
E. 40,000 sq in

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Information Needed

Bedroom floor space by square feet

Skills Needed

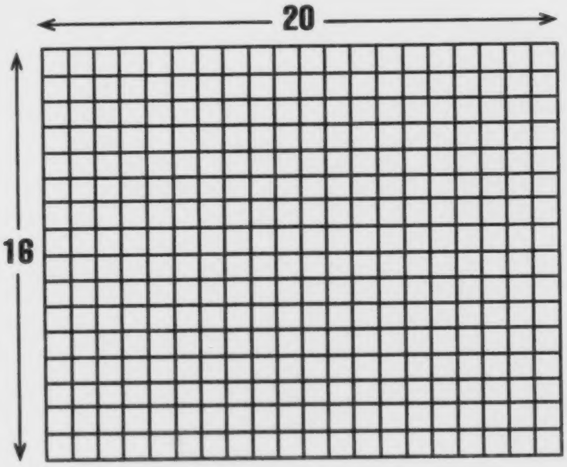
Multiplication
Conversion of units
Rounding
Calculating formula for area

Solution Method 1

Find the area of the room by length x width or 16 ft x 20 ft = 320 sq ft.
Look on the formula sheet and find out that 1 sq yd is equal to 9 sq ft.
Divide 320 sq ft by 9 sq ft = 35.5 sq yd.
Round up to 36 since you must purchase in whole yards.

Solution Method 2

Draw the room on a piece of graph paper and calculate square footage by counting the squares.



Estimate as follows: 20 ft x 20 ft = 400 sq ft/10 sq ft in a sq yd = 40 sq yd

Answer

36 square yd

Notes:

Problem 4.4: Mixed Paint

LEARNER PAGE

You're employed by a paint store. A customer wants a particular shade of green paint. To obtain this paint, you must mix blue and green dye in the ratio of 2 ounces to 3 ounces per quart of white paint. How much blue and green dye will you need to make five gallons?

INFORMATION NEEDED:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.4: Mixed Paint

INSTRUCTOR'S GUIDE

Problem

You're employed at a paint store. A customer wants a particular shade of green paint. To obtain this paint, you must mix blue and green dye in the ratio of 2 ounces to 3 ounces per quart of white paint. How much blue and green dye will you need to make five gallons?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
3. Solve and use proportions.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Ratio of mix from 2 oz (blue) to 3 oz (green) to 1 qt (white)
Customer needs five gallons

Skills Needed

Conversion (information given on the sumbols and formulas sheet)
Multiplication
Ratio

Solution Method 1

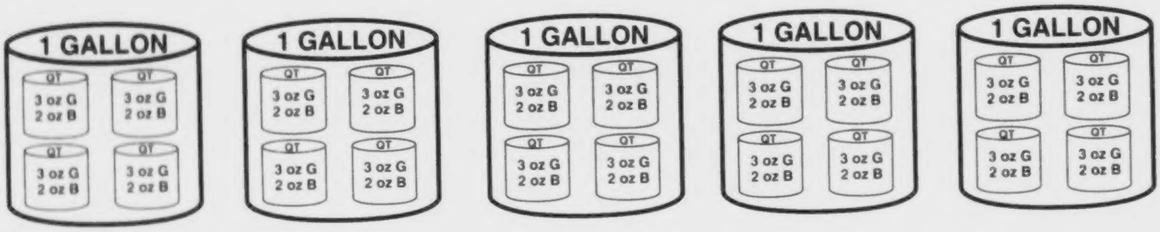
$$\frac{(2 \text{ oz blue})}{1 \text{ qt white paint}} \quad \text{x} \quad \frac{(4 \text{ qts of white})}{1 \text{ gallon}} = \frac{(5 \text{ gallons})}{\text{needed}}$$

(2 oz blue x 4 qts x 5 gallons) = **40 oz blue**

$$\frac{(3 \text{ oz green})}{1 \text{ qt white paint}} \quad \text{x} \quad \frac{(4 \text{ qts of white})}{1 \text{ gallon}} = \frac{(5 \text{ gallons})}{\text{needed}}$$

(3 oz green x 4 qts x 5 gallons) = **60 oz green**

Solution Method 2



Solution Method 3

5 gal x 4 qt/gal = 20 qt

20 qt x 2 oz blue/qt = **40 oz blue**

20 qt x 3 oz green/qt = **60 oz green**

Answer

40 oz of blue dye and 60 oz of green dye

Notes:

Problem 4.5: Odometer Reading

LEARNER PAGE

You took a six-day vacation. The odometer reading when you left home was 26,259 miles and 27,507 miles when you returned home. During the trip, you filled the car with gas four times, 15 gallons, 12 gallons, 14 gallons, and 11 gallons respectively. How many miles per gallon did the car get?

Underline the **INFORMATION NEEDED** in the above problem. Include it in your drawing.

DRAWING SPACE:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.5: Odometer Reading

INSTRUCTOR'S GUIDE

Problem

You took a six-day vacation. The odometer reading when you left home was 26,259 miles and 27,507 miles when you returned home. During the trip, you filled the car with gas four times, 15 gallons, 12 gallons, 14 gallons, and 11 gallons respectively. How many miles per gallon did the car get?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Miles driven on vacation
Gallons of gas added during the vacation

Skills Needed

Multiplication and division
Conversion

Solution Method

Miles driven is found by subtracting the ending odometer reading (27,507) from the beginning odometer reading (26,259). You drove 1,248 miles.

Gas put in the car during the trip:

15 gal + 12 gal + 14 gal + 11 gal = 52 gal

Mileage is determined by dividing the two: $\frac{\text{1,248 miles}}{\text{52 gallons of gas}} = \text{24 mpg}$

Answer

24 miles per gallon

Notes:

Problem 4.6: Suit Sale

LEARNER PAGE

A suit originally priced at $240.00 is on sale for $150.00. Calculate the percent of savings.

A. 10%
B. 17%
C. 25%
D. 37%
E. 40%

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 4.6: Suit Sale

INSTRUCTOR'S GUIDE

Problem

A suit originally priced at $240.00 is on sale for $150.00. Calculate the percent of savings.

A. 10%
B. 17%
C. 25%
D. 37%
E. 40%

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

Information Needed

Original and current price of the outfit

Skills Needed

Multiplication, division, subtraction and addition

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Solution Method 1

Write the problem in a comparison format:

$$\frac{\$240}{100\%} \qquad \frac{\$150}{x}$$

$\$150 \times \frac{100}{\$240}$ = 62.5% of the original price

100% – 62.5% = **37.5%** of savings

Solution Method 2

Original price of $240 less the sale price of $150 = $90.00 savings

$\frac{\$90.00}{\$240.00}$ = $90.00 savings on outfit = **37.5%**

Estimation

In estimating the correct answer, try to look at 10% increments:

10% of $240.00 = $24.00 savings
20% of $240.00 = $48.00 savings
30% of $240.00 = $72.00 savings
40% of $240.00 = $96.00 savings

You saved $90.00 or less than 40%!

Answer

37%

Notes:

Problem 4.7: Employment Test Scores **LEARNER PAGE**

Ron, Ed, Natalie, and Jenny were having a discussion as to who earned the highest score on an employment test. The scores were as follows:

Ron had 25 correct out of 30
Ed had 78%
Natalie had 27 correct out of 30
Jenny had $^{76}/_{100}$

List the names in ascending order based upon their test scores.

A. Ron, Ed, Natalie, and Jenny
B. Jenny, Ron, Natalie and Ed
C. Jenny, Ed, Ron and Natalie
D. Natalie, Ron, Ed and Jenny

Underline the **INFORMATION NEEDED** in the above problem.

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.7: Employment Test Scores

INSTRUCTOR'S GUIDE

Problem

Ron, Ed, Natalie, and Jenny were having a discussion as to who earned the highest score on an employment test. The scores were as follows:

Ron had 25 correct out of 30
Ed had 78%
Natalie had 27 correct out of 30
Jenny had $^{76}/_{100}$

List the names in ascending order based upon their test scores.

A. Ron, Ed, Natalie, and Jenny
B. Jenny, Ron, Natalie and Ed
C. Jenny, Ed, Ron and Natalie
D. Natalie, Ron, Ed and Jenny

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
5. Solve problems and make applications involving percentages.
7. Convert, compare, and compute with common units of measurement within the same measurement system.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

Names and scores of learners involved

Skills Needed

Conversion
Percentages
Fractions
Knowledge of ascending order

Solution Method 1

Change all test scores to decimals. (The instructor should teach learners how to do this using calculators.)

Name	Information Given	Decimal
Ron	25/30	.833
Ed	78%	.780
Natalie	27/30	.900
Jenny	76/100	.760

Put the decimal scores in ascending order as follows: **Jenny, Ed, Ron and Natalie**

Solution Method 2

Change all test scores to percentages.

Name	Information Given	Decimal x 100 = %
Ron	25/30	.833 = 83.3%
Ed	78%	.780 = 78.0%
Natalie	27/30	.900 = 90.0%
Jenny	76/100	.760 = 76.0%

Put the names in ascending order as follows: **Jenny, Ed, Ron and Natalie**

Solution Method 3

Change all test scores into fractions using 300 as the common denominator. Put the fractions in ascending order, with the smallest number listed first.

Name	Information Given		Fractions
Ron	25/30	x 100	250/300
Ed	78%	x 3	234/300
Natalie	27/30	x 100	270/300
Jenny	76/100	x 3	228/300

Put the names in ascending order as follows: **Jenny, Ed, Ron and Natalie**

Answer

Jenny, Ed, Ron and Natalie

Notes:

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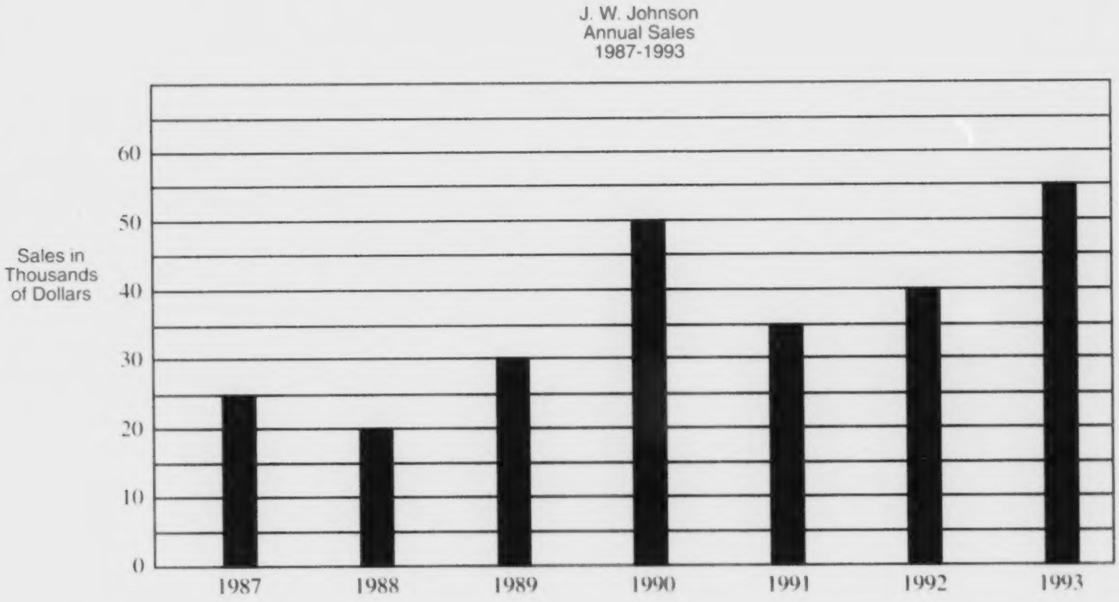
Problem 4.8: Annual Sales

LEARNER PAGE

Using the graph below, choose the top five sales years. Arrange the years in descending order according to sales.

What are the total sales for those five years?

A. 93, 92, 91, 90, 89 /210,000
B. 86, 87, 85, 83, 84 /165,000
C. 93, 90, 92, 91, 89 /210,000
D. 89, 90, 91, 92, 93 /210,000
E. 88, 89, 90, 91, 92 /185,000



Underline the **INFORMATION NEEDED** in the above problem.

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.8: Annual Sales

INSTRUCTOR'S GUIDE

Problem

Using the graph below, choose the top five sales years. Arrange the years in descending order according to sales.

What are the total sales for those five years?

A. 93, 92, 91, 90, 89 /210,000
B. 86, 87, 85, 83, 84 /165,000
C. 93, 90, 92, 91, 89 /210,000
D. 89, 90, 91, 92, 93 /210,000
E. 88, 89, 90, 91, 92 /185,000

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
12. Read, interpret, and use tables, charts, maps, and graphs to identify patterns, note trends, and draw conclusions

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Strand III: Data Analysis

6. Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions.

Information Needed

Annual sales for seven years

Skills Needed

Addition
Knowledge of descending order
Reading and interpreting graphs

Solution Method 1

Read the sales amounts on the graph, or locate the five tallest bars, to select the top five sales years. Circle these.

List the top five sales years in descending order and total, as follows:

Year	Annual Sales
1993	$ 55,000
1990	50,000
1992	40,000
1991	35,000
1989	30,000
	total: **$210,000**

Solution Method 2

Convert the graphics into a table using numbers (000 dollars)

Year	Annual Sales	Top Five Years
1987	$25,000	
1988	20,000	
1989	30,000	5
1990	50,000	2
1991	35,000	4
1992	40,000	3
1993	55,000	1

[210,000 = total of top five years]

Choose the top five years in terms of annual sales, number in descending order **(1993, 1990, 1992, 1991, 1989)** and total **(210,000)**.

Answer

1993, 1990, 1992, 1991, 1989 /210,000

Problem 4.9: Auger Feeder

LEARNER PAGE

You work for a local manufacturer. You are feeding 100 lb of material per hour with an auger feeder. The maximum feed rate at 100% motor speed is 680 lb/hour. You are currently running at 14.7% motor speed. You need to increase your materials feed rate to 210 lb/hour. To accomplish this production increase, at what speed should you set your motor?

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 4.9: Auger Feeder

INSTRUCTOR'S GUIDE

Problem

You work for a local manufacturer. You are feeding 100 lb of material per hour with an auger feeder. The maximum feed rate at 100% motor speed is 680 lb/hour. You are currently running at 14.7% motor speed. You need to increase your materials feed rate to 210 lb/hour. To accomplish this production increase, at what speed should you set your motor?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
3. Solve and use proportions.
5. Solve problems and make applications involving percentages.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Current material feed rate
Motor speed percentage
Current speed at which you need to run the job

Skills Needed

Ratio
Proportion
Percentage
Deleting extraneous information

Solution Method 1

$$\frac{\text{100 lb/hour material rate}}{\text{14.7\% motor speed}} = \frac{\text{210 lb/hour material rate}}{\text{x motor speed}}$$

(100 lb/hour)x = 210 lb/hour x .147

x = 30.87/100

x = **30.8%** motor speed

Solution Method 2

210 lb is 2.10 times the amount you are currently running the machine. material feed ?

2.10 times the motor speed of 14.7% = **30.87%**

Estimation

2 times the motor speed x 15% = 30%

Answer

30.8%

Notes:

Problem 4.10: Plywood for Roofing

LEARNER PAGE

You need to install new plywood on your roof before you can replace the shingles. The lumber company has 4′ x 8′ sheets on sale for $8.99 per sheet. Each half of your roof measures 14′ x 32′. How many sheets of plywood do you need to purchase to complete the job? How much will this plywood cost?

Underline the **INFORMATION NEEDED** in the above problem. Include it in your drawing.

DRAWING SPACE:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 4.10: Plywood for Roofing

INSTRUCTOR'S GUIDE

Problem

You need to install new plywood on your roof before you can replace the shingles. The lumber company has 4′ x 8′ sheets on sale for $8.99 per sheet. Each half of your roof measures 14′ x 32′. How many sheets of plywood do you need to purchase to complete the job? How much will this plywood cost?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Information Needed

Area of roof
Area of coverage by one sheet of plywood
Price of one sheet of plywood

Skills Needed

Addition, multiplication, division
Formula for the given area

Solution Method 1

Find the area of the roof as follows:

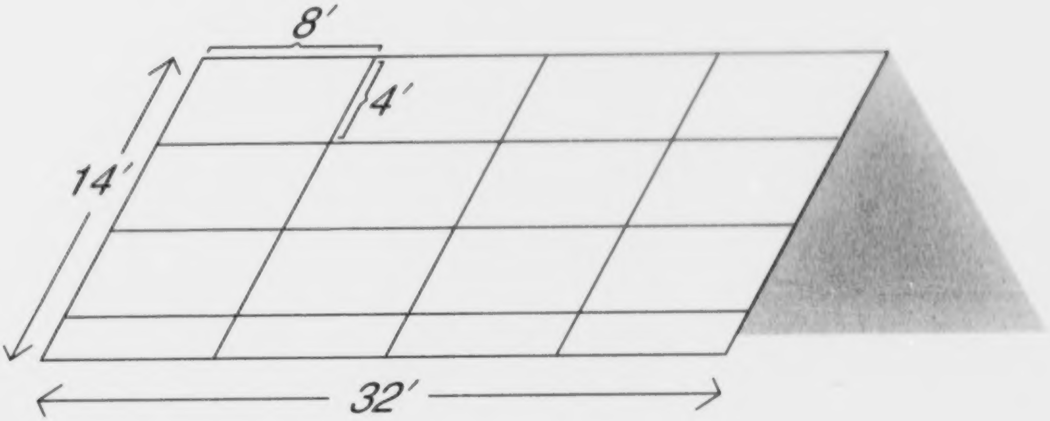
14 ft x 32 ft = 448 sq ft for ½ of the roof
448 sq ft x 2 = 896 sq ft for the entire roof

Find the area of one sheet of plywood as follows:

4 ft x 8 ft = 32 sq ft for one sheet of plywood
896 sq ft ÷ 32 sq ft = 28 sheets
Calculate the total price to cover the roof:
28 sheets x $8.99/sheet = **$251.72**

Solution Method 2

Draw a scale model of the roof and calculate coverage by placing scale model sheets on the drawing, as follows:



Answer

28 sheets of plywood for a total cost of $251.72

Notes:

MATHEMATICS

TARGETS
FOR
LEARNING

= π

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Improving to Level 5 INDEX

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About Level 5 Problems

Level 5 learners can

1. Perform applications described in the previous levels.
2. Separate the important facts from extraneous information.
3. Look up formulas and use them appropriately to perform one-step unit conversions within or between systems of measurement. The formulas provided on p. 347 can be used to make conversions (e.g., pounds to ounces, kilograms to pounds).
4. Calculate using mixed units. For example, workers often need to solve problems that involve calculations such as 5.5′ + 6′11″ or 9.25 hours – 2 hours 30 minutes.
5. Calculate perimeters and areas of basic shapes. Workers need to use the correct formula from those provided in the Work Keys System to find the perimeter and/or area of circles, rectangles, and triangles.
6. Calculate percentage discounts or markups, or complete a balance sheet or order form. Level 4 problems require workers to make these types of multi-step calculations.
7. Calculate the "best buy" using one- or two-step calculations to compare two costs. To do this, workers need to select the information that is needed to make the calculations, perform the calculations, and compare the results of those calculations.

Characteristics of Level 5 problems

- Problems often involve money, quantity, and time applications.
- Problems often combine quantity and time applications in rate problems.
- Problems include more extraneous and more complex information than previous levels, resulting in operations and solutions that are less obvious.

Notes:

Instructional Strategies for Helping Learners Improve to Level 5

When introducing a new skill, give learners as many work-related activities and problems as possible. Completing these activities will help learners to recognize that the new skills relate to real-world applications and skills that they already have. Thus, the new material will have more meaning to them.

Using the practice problems in *Targets for Learning* is not enough to teach learners to solve math-related workplace problems. **Instructors need to provide learners with a wide variety of hands-on learning experiences.** In most cases, it is important to conduct such activities **before** presenting learners with the practice problems in *Targets for Learning*.

This section provides suggested learning activities and worksheets. Instructors may also wish to use some of the resources listed in Appendix B to develop other learning opportunities for Level 5 learners. In addition, refer to *Targets for Instruction*, pp. 49-58, for instruction suggestions specific to Level 5 learners.

When developing practice problems, remember that Level 5 problems involve multiple steps and include extraneous information. Be sure that you include both in learning activities and practice problems. In addition, Level 5 problems often involve money, quantity, and time applications. And rate problems often combine quantity and time applications.

Suggested Learning Activities

Measurement

Level 5 learners must calculate perimeters and areas of basic shapes. Some ways they can practice these skills include:

- Help learners calculate perimeter and area of basic shapes. For example, have them calculate the amount of paint that will be needed to cover the walls of a given room or building. Or have them determine the amount of materials needed for a project, such as wallpaper, paint, flooring, decking, or fertilizer. See the worksheet examples on pp. 167-168.
- Ask learners to calculate the amount of area that can be enclosed by a given amount of fencing. See the worksheet examples on pp. 166-167.
- Have learners make calculations using mixed units (e.g., measurements made in a combina-tion of feet and inches, such as 5′6″) and conversions. See the worksheet examples on pp. 169 and 172.
- Have learners practice reducing lists of mixed units (i.e., denominate numbers). See the worksheet examples on p. 157.

Denominate Numbers

Level 5 learners must be able to reduce measurements that are listed in denominate numbers—or mixed units. Many money, quantity, and time applications involve denominate numbers. Many Level 5 problems require workers to read, record, reduce, and make calculations with mixed numbers. These practice activities can help:

- Using tape measures, have learners read measurements in inches, and in feet and inches.
- Give learners mixed numbers and have them write word problems that fit those numbers. See the worksheet example on p. 157.
- Provide a variety of containers for cups, pints, quarts, gallons. Let learners "change" units by pouring quantities from one size container to another.

Provide learners with practice in determining denominate numbers. For example, have them reduce measures listed on the Mixed Number Worksheet, p. 157, to the simplest form. (Note: this worksheet can also be used to assess learners' skills with denominate numbers.)

Fractions

Fractions are commonly used with averages, measurement, and quantity. Level 5 fractions may have exponents (e.g., 3^2) or more than one term in the numerator or denominator. In addition, Level 5 learners must add and subtract fractions with unlike denominators. They also need to multiply and divide fractions with like denominators, and multiply a fraction by a decimal. Appropriate practice problems include increasing family-size recipes for use with large groups. See the worksheet example on p. 169.

Percentages

Level 5 learners need to calculate what percentage one number is of another. In addition, they need to find a percent of a fraction or a decimal. See the worksheet examples on pp. 170-171.

- Provide learners with catalogs or ads for calculating the percentage of discounts or markups.
- Have learners calculate the percentage of increase or decrease in sales, production, and/or employment.
- Allow learners to complete balance sheets and order forms that involve percentages of increase or decrease.

Ratios and Proportions

Have learners determine the quantities of ingredients needed to make chemical solutions. For example, learners can be asked to determine the amounts of insecticide and water that should be mixed for spraying a given number of plants. See the worksheet on p. 165 for paper-and-pencil examples. Hands-on activities can be developed from those and similar problems.

Production Rates

Level 5 learners can predict rates by using proportions. Rate problems at this level include whole numbers. Rate problems often deal with production (i.e., a combination of quantity and time applications). In addition, learners at this level need to predict rates (e.g., rate of use, rate of speed, and rate of growth). For example, production predictions can be made by calculating and analyzing current and/or past usage trends.

Best Buy

Learners should calculate the "best buy" using one-step and two-step calculations to *compare two costs*. This is done by making two separate money-related calculations and then comparing them. Key words (e.g., lower cost, cheaper, save, more expensive) involved in this type of problem can be stressed.

- Practice problems can involve comparing two costs of any type of retail product or consumer service including car rentals, telephone service, day care, cable service, satellite dishes, and major home appliances. See the worksheet examples on pp. 158-159.

- Let learners use the prices found in grocery ads to determine unit prices. See the worksheet examples on pp. 160-161.

- Provide charts from shipping companies, such as UPS, so that learners can calculate shipping charges for packages at different weights. (Note: weights should include decimals, fractions, and/or units that have to be converted.) See the worksheet example on pp. 162-164.

Examples of Learning Activities

The worksheets on the following pages were developed by the teachers and industry trainers who wrote or piloted *Targets for Learning*. Instructors who are helping learners improve to Level 5 may wish to use these exercises in their classes. These worksheets can also be used as pre-instruction and/or post-instruction assessments. In addition, instructors may wish to develop similar exercises.
Worksheets and solution sheets are provided on the following topics:

- Mixed Numbers (p. 157)
- Best Buys (pp. 158-159)
- Unit Prices (pp.160-161)
- Shipping Costs (pp. 162-164)
- Mixtures and Proportions (p. 165)
- Perimeter and Area (pp. 166-167)
- Area (p. 168)
- Proportions and Mixed Numbers (p. 169)
- Percent Increase and Decrease (pp. 170-171)
- Metrics/Customary Conversions (p. 172)

Instructors are encouraged to develop additional questions and/or hands-on learning activities, using the information provided on the worksheets.

Improving to Level 5

Mixed Number Worksheet

For each of the following measures, make up a word problem that fits it. Then reduce the measures to the simplest form.

1. 4 lb 35 oz
2. 8 gal 6 qt 3 pt
3. 3 mi 11,450 ft
4. 6 hr 129 min
5. 7 yd 8 ft 17 m
6. 3 qt 7pt 4 c
7. 2 days 56 hr
8. 5 m 350 cm
9. 2 kg 8190g
10. 15 yd 4 ft 50 in

Solutions to this worksheet are provided on p. 173.

Best Buy

Worksheet I

1. Dan's Discount Store has motor oil for $19.95 a case (12 qts per case). NAPA Auto Supply has the same oil for $1.75 a quart.

   A. Which is the better buy?

   B. How much would you save on 12 quarts?

2. Dunham's Sports Center sells 2 tennis rackets with covers at a sale price of two for $129.99. At Meijer's, similar rackets are $125.99 each with a manufacturer's rebate of $5.00 each. The cover costs an additional $2.98 each.

   A. Which store offers the better price?

   B. How much lower is the price?

3. A 1 ¼ lb box of Brand X cereal sells for $4.49. A 1½ lb box of Brand Y cereal sells for $4.79.

   A. Calculate the cost per pound of each brand.

   B. Calculate the difference in price per pound.

   C. Which brand costs less per pound?

4. Two stores offer 50,000-mile tires at the following prices. Store A: regularly $296.00 for 4 tires, currently offering a 15 % discount. Store B: $65.00 per tire, currently giving a $5.00 rebate per tire. Which store offers the better sale price?

Solutions to this worksheet are provided on p. 174.

Best Buy

Worksheet II

1. Currently, you have cable service that costs $42.85 per month. You're considering changing to Dish Network, which requires an initial investment of $199.00 for the system, plus $300.00 for a 1-year subscription to a programming package. Which is the better buy? At what savings?

2. You and your family are flying to Orlando for a five day vacation. You need to rent a car, and have two rental plans to consider.

   Plan A: $189.00/week, plus 7% tax for unlimited miles

   Plan B: $27.95/day, $.18 per mile

You estimate that your vacation plans will require 300 miles. Which plan will cost less? How much less?

Solutions to this worksheet are provided on p. 174.

Unit Prices

Worksheet I

Your local grocery store offers the following items. Find the unit prices to the nearest 10th cent.

Purina Dog Chow® 22-lb bag **$6.98**	Calculate the cost per pound.
Kraft® Salad Dressing 16 oz **$1.58**	Calculate the cost per ounce.
Ragu® Old World Style Spaghetti Sauce 27oz **2/$3**	Calculate the cost per ounce.
Store Brand Orange Juice Limit 3 please (half gal) **78¢**	Calculate the cost per ounce.

Solutions to this worksheet are provided on p. 175.

Unit Prices

Worksheet II

1. Western Auto sells spray paint at $.79 for 11 oz. Find the price per ounce to the nearest 10th of a cent.

2. A 16-oz can of Son-of-a-Gun sells for $2.99. Calculate the price per ounce to the nearest 10th of a cent.

3. 12.5 gal of gasoline cost $15.99. To the nearest 10th of a cent, calculate the price per gal.

4. 42 ft of heater hose cost $35.70. Calculate the cost per ft.

5. A car is driven 38,460 miles in one year at a cost of $14,384.04. Calculate the cost per mile.

Solutions to this worksheet are provided on p. 175.

Shipping Costs

Worksheet

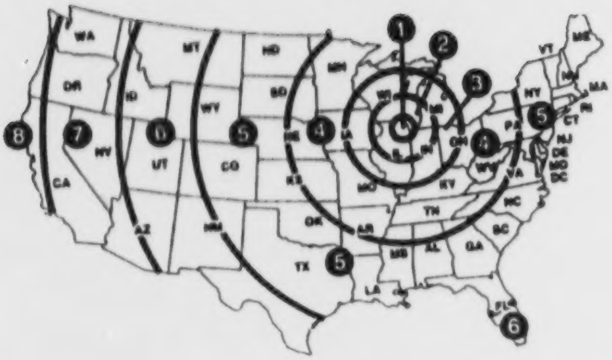
For each of the following problems, complete these tasks:

- Locate the correct pricing form on the Parcel Post Pricing Maps found on the following page.
- Calculate the shipping cost using the UPS 3-Day Select Rates chart found on the following page.

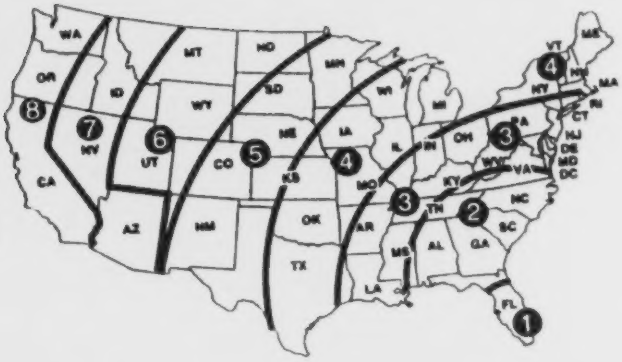
1. How much does it cost to ship a 65 lb package from Orlando, Florida to Las Vegas, Nevada?
2. How much does it cost to ship a 31 lb 10 oz package from Reno, Nevada to Chicago, Illinois?
3. How much does it cost to ship a 92 lb package from Northbrook, Illinois to New Orleans?
4. How much does it cost to ship an 86 lb 2 oz package from Lakewood, New Jersey to Columbus, Ohio?
5. How much does it cost to ship an 150 lb package from Orlando, Florida to Atlanta, Georgia?

Solutions to this worksheet are provided on p. 176.

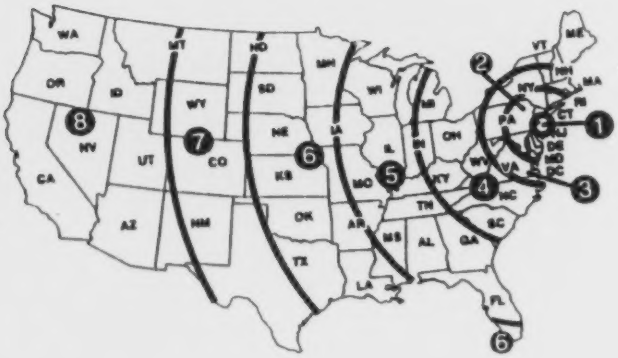
Northbrook, Illinois Zones



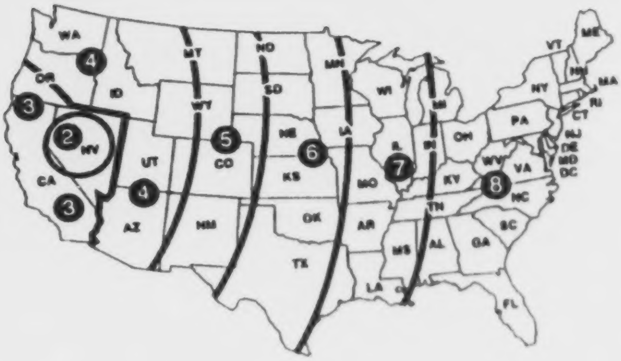
Orlando, Florida Zones



Lakewood, New Jersey Zones



Reno, Nevada Zones



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Weight and Size Limits

Maximum weight per package . . . . . .150 lbs.
Maximum size per package . . . . .130 inches in length and girth combined
. . . . with a maximum length of 108 inches per package

UPS 3-Day Select Rates

Guaranteed 3-day delivery!

Wt	ZONES						
Lbs	1-2	3	4	5	6	7	8
1	$ 4.37	$ 4.39	$ 4.40	$ 4.42	$ 4.45	$ 4.47	$ 4.49
2	4.85	4.90	4.95	4.99	5.02	5.05	5.06
3	5.38	5.43	5.50	5.52	5.55	5.63	5.70
4	5.85	5.90	5.95	6.00	6.05	6.10	6.14
5	6.50	6.55	6.58	6.61	6.65	6.70	6.78
6	7.23	7.30	7.40	7.43	7.47	7.55	7.63
7	7.95	8.01	8.12	8.21	8.30	8.40	8.48
8	8.85	8.89	9.00	9.10	9.29	9.46	9.49
9	9.74	9.78	9.88	10.00	10.23	10.40	10.48
10	10.46	10.50	10.59	10.75	11.00	11.24	11.46
11	11.35	11.39	11.48	11.69	11.96	12.23	12.47
12	12.24	12.29	12.38	12.63	12.93	13.22	13.48
13	12.95	13.02	13.12	13.39	13.72	14.04	14.32
14	13.75	13.85	13.95	14.33	14.69	15.03	15.33
15	14.50	14.60	14.70	15.10	15.50	15.84	16.17
16	15.10	15.13	15.30	15.92	16.20	17.12	17.34
17	15.71	15.88	16.05	16.85	17.14	18.13	18.47
18	16.40	16.58	16.77	17.61	17.92	18.96	19.32
19	17.09	17.28	17.49	18.36	18.70	19.79	20.17
20	17.96	18.15	18.37	19.30	19.65	20.80	21.20
21	18.66	18.86	19.09	20.06	20.43	21.63	22.05
22	19.52	19.73	19.97	20.99	21.38	22.64	23.08
23	20.22	20.43	20.69	21.75	22.16	23.47	23.93
24	20.92	21.14	21.41	22.51	22.93	24.30	24.76
25	21.61	21.84	22.12	23.27	23.71	25.13	25.63
26	22.30	22.54	22.85	24.03	24.49	25.95	26.48
27	23.00	23.25	23.57	24.79	25.26	26.78	27.33
28	23.68	23.96	24.28	25.55	26.04	27.61	28.17
29	24.37	24.66	25.00	26.31	26.82	28.44	28.95
30	25.07	25.36	25.72	27.08	27.61	29.28	29.89
31	25.76	26.07	26.46	27.85	28.40	30.11	30.70
32	26.45	26.78	27.18	28.62	29.19	30.96	31.55
33	27.14	27.49	27.91	29.39	29.98	31.79	32.46
34	27.83	28.20	28.63	30.14	30.76	32.63	33.32
35	28.52	28.91	29.34	30.91	31.54	33.47	34.18

Wt.	ZONES						
Lbs.	1-2	3	4	5	6	7	8
36	$29.21	$29.62	$30.06	$31.67	$32.32	$34.29	$34.90
37	29.90	30.33	30.79	32.43	33.10	35.13	35.88
38	30.57	31.03	31.50	33.19	33.88	35.95	36.60
39	31.26	31.73	32.22	33.95	34.66	36.79	37.58
40	31.95	32.43	32.94	34.71	35.43	37.62	38.43
41	32.63	33.14	33.66	35.47	36.21	38.45	39.28
42	33.32	33.84	34.38	36.23	36.99	39.27	40.13
43	34.01	34.55	35.10	36.99	37.77	40.11	40.90
44	34.70	35.26	35.82	37.75	38.55	40.93	41.75
45	35.38	35.96	36.54	38.51	39.33	41.76	42.68
46	36.08	36.67	37.26	39.28	40.11	42.60	43.53
47	36.76	37.37	37.97	40.03	40.89	43.43	44.38
48	37.44	38.07	38.69	40.80	41.66	44.25	45.22
49	38.12	38.76	39.41	41.55	42.42	45.08	46.06
50	38.81	39.45	40.11	42.30	43.17	45.89	46.89
51	39.48	40.14	40.80	43.02	43.91	46.68	47.70
52	40.15	40.81	41.48	43.73	44.64	47.44	48.47
53	40.65	41.32	41.99	44.27	45.18	48.01	49.05
54	41.15	41.82	42.50	44.81	45.72	48.59	49.63
55	41.65	42.33	43.01	45.34	46.26	49.17	50.20
56	42.15	42.83	43.52	45.88	46.79	49.73	50.78
57	42.65	43.34	44.02	46.41	47.33	50.30	51.35
58	43.15	43.84	44.53	46.94	47.86	50.88	51.93
59	43.66	44.35	45.04	47.48	48.40	51.45	52.50
60	44.16	44.85	45.55	48.01	48.94	52.02	53.08
61	44.66	45.35	46.06	48.55	49.48	52.59	53.66
62	45.16	45.85	46.57	49.09	50.02	53.17	54.23
63	45.67	46.35	47.08	49.62	50.56	53.74	54.81
64	46.17	46.85	47.59	50.15	51.09	54.32	55.39
65	46.67	47.35	48.10	50.69	51.63	54.89	55.96
66	47.17	47.85	48.61	51.23	52.17	55.46	56.55
67	47.67	48.35	49.11	51.76	52.70	56.04	57.12
68	48.17	48.85	49.62	52.30	53.24	56.61	57.70
69	48.67	49.35	50.13	52.84	53.78	57.19	58.28
70	49.17	49.85	50.64	53.37	54.31	57.76	58.86

ANY FRACTION OF A POUND OVER THE WEIGHT SHOWN TAKES THE NEXT HIGHER RATE

Prices subject to change without notice.

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Improving to Level 5

Mixtures and Proportions

Worksheet

1. To prepare a lawn pest control application, you mix 1½ tablespoon pest control concentrate to 3 gal water. If you use 12 tablespoons of concentrate, how much water will you need?

2. The dilution ratio for an all purpose cleaner to water is 1:64. If you use 3 oz of cleaner, how much water should you use? (Express your answer in gallons.)

3. To prepare a bathroom cleaner, the ratio of concentrate to water is 1:5. If you use 1 pint of water, how many ounces of concentrate should you use?

Solutions to this worksheet are provided on p. 177.

Perimeter and Area

Worksheet

Each learner should have a piece of $\frac{1}{4}''$ graph paper ($\frac{1}{4}''$ = 1 unit) or a ruler.

1. A. Draw five different rectangles having a perimeter of 20.

   B. Find the area of each rectangle.

   C. Form a conclusion about the shape of the rectangle with the greatest area.

D. Draw 6 different rectangles having a perimeter of 26.

E. Find the area of each of these rectangles.

F. Does your conclusion from question C work with this set of rectangles?

G. Make a generalization about the shape of a rectangle with the greatest area.

2. Joe received a puppy named Duke for his birthday. Right now Duke weighs 10 pounds 5 ounces but will eventually weigh 75 pounds. Joe has 56 ft of fence to make a play area for Duke. Using the 56 ft of fence, what dimensions of a rectangular pen that would give Duke the largest play area?

Solutions to this worksheet are provided on p. 178.

Area

Worksheet

Hint: Draw a diagram for each problem.

1. Your customer waiting area is 11 ft by 12 ft. How many sq yards of carpeting (to the nearest whole sq yard) are needed to cover it?

2. Several rooms in your house are to be painted with two coats of True White paint. After measuring, you calculated the wall and ceiling surface to be 100 sq yd, excluding windows and doors. If 1 gallon of paint covers 400 sq ft, how many gallons of paint do you need to buy?

3. One bag of lawn fertilizer will cover 15,000 sq ft and costs $21.50. You have one acre to cover. You must buy full bags of fertilizer. How much will the fertilizer cost you?

4. A floor that measures 108 ft^2 is to be covered with floor tiles. Each tile measures 100 in^2. The tiles come in boxes of 25. How many boxes of tile are needed?

5. The walls of a room are to be covered with wall paper. The room is 17 ft long, 13 ft wide, and 8 ft high. It has one doorway 3 ft by 7 ft and two windows 3 ft by 4 ft. Each roll of wallpaper covers an area of 20 ft^2. How many rolls of wallpaper are needed?

Solutions to this worksheet are provided on p. 179.

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Improving to Level 5

Proportions and Mixed Numbers

Worksheet

The following recipe is for 8 servings. Increase the recipe to 40 servings. Be sure to reduce compound mixed amounts to the simplest terms.

Peach Praline Shortcake

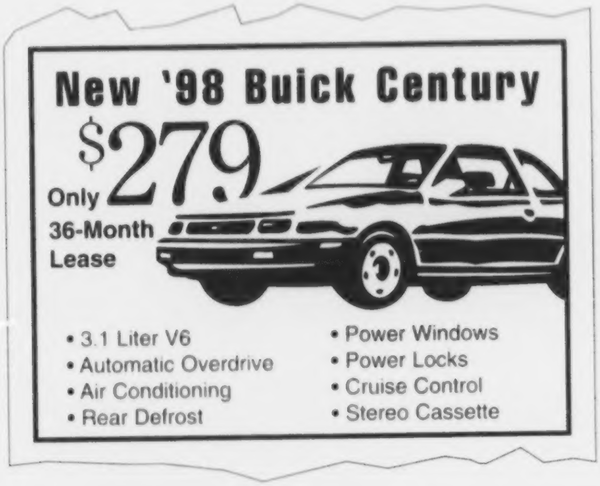
$1\frac{1}{2}$ c flour
3 t baking powder
$\frac{1}{2}$ t salt
$\frac{1}{4}$ t soda
$\frac{1}{2}$ c brown sugar (packed)
$\frac{1}{3}$ c shortening
$\frac{1}{2}$ c coarsely chopped pecans
1 egg
$\frac{3}{4}$ c milk
4 c sliced fresh peaches, sweetened
1 c dairy sour cream
$\frac{1}{2}$ c brown sugar

Solutions to this worksheet are provided on p. 180.

Percent Increase/Decrease

Worksheet I

1. To the nearest 10th percent, what is the percent increase in lease price from the Century to the Regal?

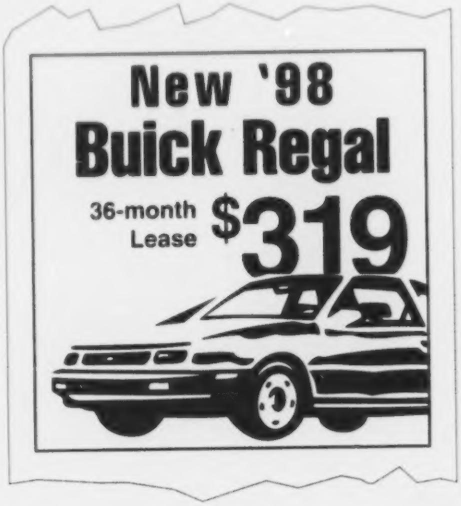


New '98 Buick Century

Only $279

36-Month Lease

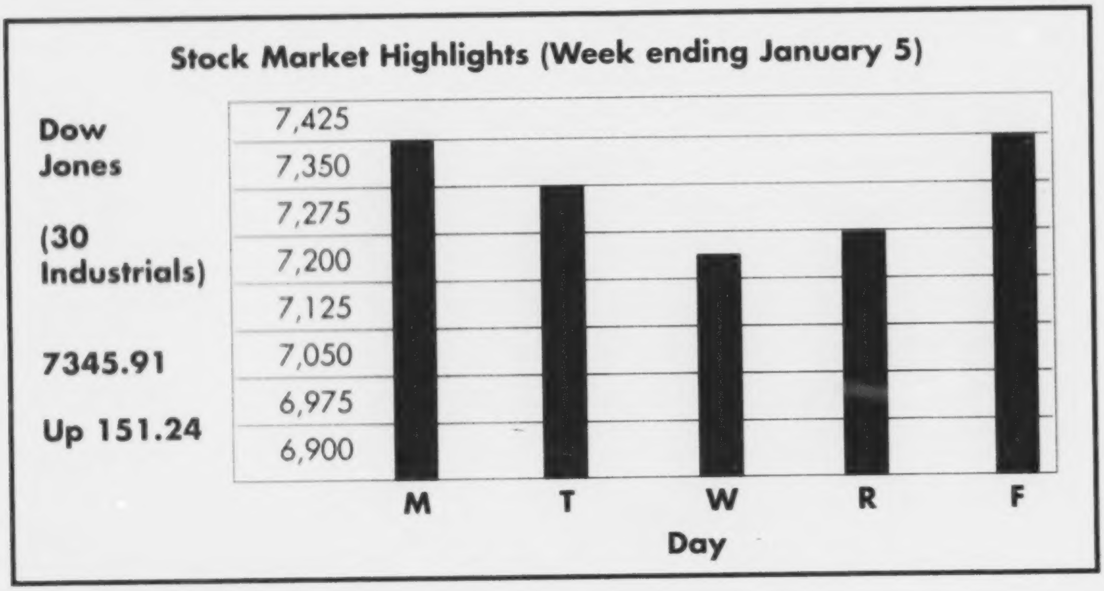
- 3.1 Liter V6
- Automatic Overdrive
- Air Conditioning
- Rear Defrost
- Power Windows
- Power Locks
- Cruise Control
- Stereo Cassette



New '98 Buick Regal

36-month Lease $319

2. What is the percent increase in the Dow Jones from Monday to Tuesday (give answer to the nearest 10th percent)?



Improving to Level 5

Percent Increase/Decrease

Worksheet II

1. Your present wage is $8.50/hr. You just received a satisfactory 6-month work evaluation, so your pay will increase to $8.75/hr. Calculate the percent increase in your wage to the nearest 10th percent?

2. Your company presently employs 122 people. Due to increased business, they will be hiring 15 new employees. To the nearest 10th percent, calculate the percent increase in employees.

3. Your community had 309 unemployed people last month, but this month the number of unemployed dropped to 280. To the nearest 10th percent, what is the percent of decrease in unemployment?

Solutions to this worksheet are provided on p. 180.

Improving to Level 5

Metrics/Customary Conversions

Worksheet

1. A metric bolt is 1.6 cm long. How long is it in inches (to the nearest 1000th in)?

2. A Porsche weighs 1580 kg. Calculate its weight in pounds.

3. You buy gasoline in Toronto during a trip to Canada. The pump shows you needed 53.8 liters to fill your tank. How many gallons did you add to your gas tank (to the nearest 10th gal)?

4. You are shipping a box to Mexico that weighs 9 oz. How many grams does it weigh?

5. A business associate from Japan is driving from the airport to your industrial plant 35 miles away. He wants to know the distance in kilometers. Give the answer to the nearest 10th km.

6. You are shipping some parts to a client in France. You tell your contact that the shipping box is a 4 ft cube. She asks for the dimensions in meters. Give your answer to the nearest 1000th m.

Solutions to this worksheet are provided on p. 181.

Improving to Level 5

Solutions to the Mixed Number Worksheet

Word problems will vary. The mathematical solutions follow.

1. 4 lb 35 oz
   35 ÷ 16 oz in a lb = 2 lb 3 oz + 4 lb = **6 lb 3 oz**

2. 8 gal 6 qt 3 pt
   3 pt ÷ 2 pt in a qt = 1qt 1 pt + 6 qt = 7 qt 1 pt
   7 qt ÷ 4 qt in a gal = 1 gal 3 qt + 1 pt
   1 gal 3 qt 1 pt + 8 gal = **9 gal 3 qt 1 pt**

3. 3 mi 11,450 ft
   11,450 ÷ 5,280 ft in a mi = 2 mi 880 ft + 3 mi = **5 mi 880 ft**

4. 6 hr 129 min 75 sec
   75 ÷ 60 sec in a min = 1 min 15 sec + 129 min = 130 min 15 sec
   130 min ÷ 60 sec in a min = 2 hr 10 min + 6 hr = 8 hr 10 min + 15 sec = **8 hr 10 min 15 sec**

5. 7 yd 8 ft 17 in
   17 in ÷ 12 in. in a ft = 1 ft 5 in + 8 ft = 9 ft 5 in
   9 ft ÷ 3 ft in a yd = 3 yd + 7 yd = 10 yd + 5 in = **10 yd 5 in**

6. 3qt 7pt 4c
   4c ÷ 2 pt in a c = 2 pt + 7 pt = 9 pt
   9 pt ÷ 2 pt in a qt = 4 qt 1 pt + 3 qt = **7 qt 1 pt**

7. 2 days 56 hr
   56 ÷ 24 hrs in a day = 2 days 8 hr + 2 days = **4 days 8 hr**

8. 5m 350cm
   350 ÷ 100 cm in a m = 3 m 50 cm + 5 m = **8 m 50 cm**

9. 2kg 8190g
   8190 ÷ 1000 kg in a g = 8 kg 190 g + 2 kg = **10 kg 190 g**

10. 15yd 4ft 50in
    50 ÷ 12 in. in a ft = 4 ft 2 in + 4 ft = 8 ft 2 in
    8 ft ÷ 3 ft in a yd = 2 yd 2 ft + 15 yd = 17 yd 2 ft + 2 in = **17 yd 2 ft 2 in**

Solutions to the Best Buy Worksheet I

1. A. NAPA: $1.75 x 12 = $21.00
   Dan's Discount
   B. $21.00 – $19.95 = **$1.05**

2. A. Meijer's (2 x $15.99) + (2 x $2.98) – 10 = $27.94
   Meijer's
   B. $29.99 – $27.94 = **$2.05**

3. A. Brand X = $4.49 ÷ 1.25 = **$3.59/lb**
   Brand Y = $4.79 ÷ 1.5 = **$3.19/lb**
   B. $3.59 – $3.19 = $0.40/lb
   C. Brand Y

4. Store A: $296.00 – (15% x $296.00) = **$251.60**
   Store B: $65.00 – $5.00 = **$60.00**
   $60.00 x 4 = **$240.00**
   Store B offers the better price.

Solutions to the Best Buy Worksheet II

1. Cable: 12 x $42.85 = $514.20
   Dish Network: $199.00 + $300.00 = $499.00
   Dish Network is a better buy: $514.20 – $499.00 = **$15.20 saved**

2. Plan A: $189.00 + (7% x $189.00) = $202.23
   Plan B: ($27.95 x 5) + ($.18 x 300) = $139.75 + $54.00 = $193.75
   Plan B costs less: $202.23 - $193.75 = **$8.48 less**

Improving to Level 5

Solutions to the Unit Prices Worksheet I

1. $6.98 ÷ 22 = **31.7¢ per lb**
2. $1.58 ÷ 16 = **9.9¢ per oz**
3. $3.00 ÷ 54 = **5.6¢ per oz** or $1.50 ÷ 27 = **5.6¢ per oz**
4. $.78 ÷ 64 = **1.2¢ per oz**

Solutions to the Unit Prices Worksheet II

1. $.79 ÷ 11 = **7.2¢/oz**
2. $2.99 ÷ 16 = **18.7¢/oz**
3. $15.99 ÷ 12.5 = **$1.27/gal**
4. $35.70 ÷ 42 = **$.85/ft**
5. $14,384.04 ÷ 38,460 = **$0.374/mi**

Solutions to the Shipping Costs Worksheet

1. Zone 7		**$54.89**
2. Zone 7		
Use 32 lb		**$30.96**
3. Zone 5		
Use 92 lb	70 -	$53.37
	22 -	20.09
		$74.36
4. Zone 4		
Use 87 lb	70 -	$50.54
	17 -	16.05
		$66.69
5. Zone 4		
Use 121 lb	70 -	$50.64
	51 -	40.80
		$91.14
6. Zone 2		
Use 150 lb	70 -	$49.17
	70 -	49.17
	10 -	10.46
		$108.80

Solutions to the Mixtures and Proportions Worksheet

1. $\frac{1.5}{3} = \frac{12}{x}$ or $\frac{15}{12} = \frac{3}{x}$

   36 gal = 1.5x
   24 gal = x

2. $\frac{1}{64} = \frac{3}{x}$

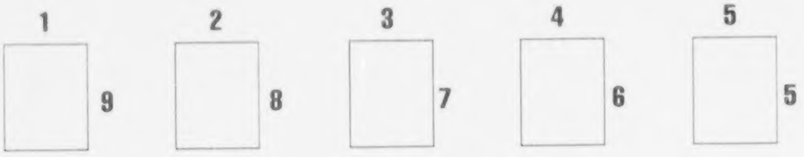
   192 oz = x
   192 oz ÷ 128 oz/gal = **1.5 gal**

3. $\frac{1}{5} = \frac{x}{16}$

   5x = 16
   x = **3 ⅕ oz**

Solutions to the Perimeter and Area Worksheet

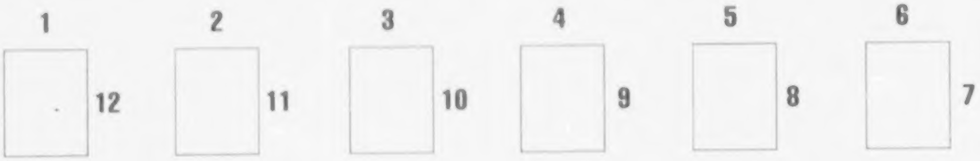
1. A. The perimeter is 20. The sum of a length and a width equals 20 ÷ 2 or 10.



B. 9 units^2 16 units^2 21 units^2 24 units^2 25 units^2

C. Square or rectangle with sides closest in length

D. If the perimeter is 26, the sum of a length and a width equals 26 ÷ 2 or 13.



E. 12 units^2 22 units^2 30 units^2 36 units^2 40 units^2 42 units^2

F. Yes

G. Rectangle with sides closest in size or square has greatest area

2. A square with 14-ft sides

Improving to Level 5

Solutions to the Area Worksheet

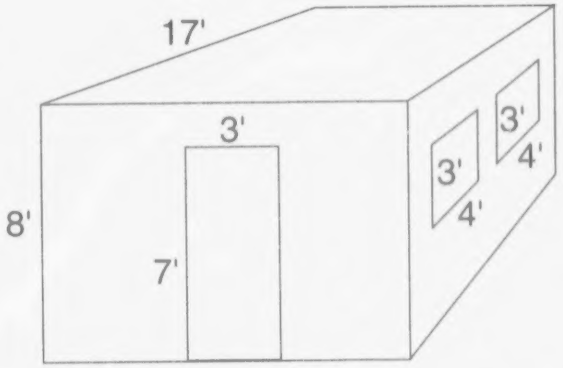
1. 11 x 12 = 132 ft^2 ÷ 9 ft^2/yd^2 = 14 $^2/_3$ yd^2
   Round to **15 yd^2**

2. 100 yd^2 x 2 coats paint = 200 yd^2 x 9 ft2/yd^2 = 1800 ft^2
   1800 ÷ 400 = 4.5 gal
   Round to **5 gal**

3. 1 acre = 43.560 ft^2
   43,560 ÷ 15,000 = 2.9
   Round to 3 bags
   3 x $21.50 = **$64.50**

4. 108 ft x 144 = 15,552 in^2
   15,552 ÷ 100 = 155.5 x 156 tiles are needed
   156 ÷ 25/box = 6.24
   Rounded to **7 boxes**

5. 17 ft x 8 ft x 2 walls = 272 ft^2
   13 ft x 8 ft x 2 walls = 208 ft^2
   272 ft^2 + 208 ft^2 = 480 ft^2
   Door: 3ft x 7ft = 21 ft^2
   Windows: 3ft x 4ft x 2 windows = 24 ft^2
   480 ft^2 – 21 ft^2 = 459 ft^2 – 24 ft^2 = 435 ft^2 total area
   435 ÷ 70 ft per roll = 6.2 rolls
   Round to **7 rolls**



Solutions to the Proportion and Mixed Number Worksheet

40 ÷ 8 = five times as much

The Conversion Calculation	The 40-Serving Result
1 ½ x 5 = 3/2 x 5	7 ½ c flour
3 x 5	15 t (15 ÷ 3 = 5T) baking powder
½ x 5 = 5/2	2 ½ t salt
¼ x 5 = 5/4	¼ t soda
½ x 5 = 5/2	2 ½ c brown sugar
⅓ x 5 = 5/3	1 ⅔ c shortening
½ x 5 = 5/2	2 ½ c pecans
1 x 5	5 eggs
¾ x 5 = 15/4	¾ c milk (1 pt 1 ¾ c)
4 x 5	20 c peaches (10 pt)
1 x 5	5 c sour cream (2 pt 1 cup)
½ x 5 = 5/2	2 ½ c brown sugar

Solutions to the Percent Increase/Decrease Worksheet I

1. 319 – 279 = $40 increase
   40 ÷ 279 = **14.3%**

2. Answers may differ due to variations in reading the graph.
   Monday ≈ $7237.50
   Tuesday ≈ $7300
   $7300.00 – $7237.50 = $62.50
   $62.50 ÷ $7237.50 = **0.9%**

Solutions to the Percent Increase/Decrease Worksheet II

1. $8.75 – $8.50 = $.25
   $.25 ÷ $8.50 = **2.9%**

2. 15 ÷ 122 =12.3%

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3. 309 – 280 = 29
   29 ÷ 209 = **9.4%**

Improving to Level 5

Solutions to the Metrics/Customary Conversions Worksheet

1. $\frac{1\text{in}}{x\text{in}} = \frac{2.54\text{cm}}{1.6\text{cm}}$

   $\frac{1.6\text{cm}}{2.54} = \frac{2.54x}{.630\text{in}}$

   $2.54\ x = 1.6\ \text{cm}$

   $x = \frac{1.16\ \text{cm}}{2.54\ \text{cm}}$

   $x = .456\ \text{in}$

2. $\frac{1\text{kg}}{1580\text{kg}} = \frac{2.2\text{lb}}{x}$

   $x = 1580\ \text{kg}\ x\ 2.2\ \text{lb}$
   $x = 3476\ \text{lb}$

3. $\frac{1\text{L}}{53.8\text{L}} = \frac{0.264\text{g}}{x}$

   $x = 0.264\ 53.8$
   $x = 14.2\ \text{gal}$

4. $\frac{1\text{oz}}{9\text{oz}} = \frac{28.350\text{g}}{x}$

   $x = 9x28.350$
   $x = 255.15\ \text{g}$

5. $\frac{1\text{km}}{x} = \frac{0.62\text{mi}}{35}$

   $0.62x = 35$
   $X = 56.5\ \text{km}$

6. $\frac{1\text{ft}}{4\text{ft}} = \frac{0.3048\text{m}}{x}$

   $x = 4\ x\ 0.3048$
   $x = 1.219\ \text{mi}$

Notes:

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Practice Problems for Improving to Level 5

Each of the following problems begins with a Learner Page, which presents a problem for learners to solve and, in some cases, guides learners through the problem-solving process. Each Learner Page is followed by an Instructor's Guide, which includes—

- the problem, as stated in the Learner Page
- information needed to solve the problem
- skills needed to solve the problem
- Ohio mathematics proficiency outcomes that pertain to the problem
- one or more methods for solving the problem
- a method for checking the answer through estimation, if appropriate

Refer to a comprehensive list of suggestions for using these practice problems in the sections titled Where Do I Begin? and How Should I Structure Learning Activities? on pp. 23-33.

In almost all cases, there is more than one way to solve a math problem. The teachers and industry trainers who wrote these problems provided more than one solution method when appropriate. In addition, learners may discover or explore approaches that are not described in this book. Instructors are encouraged to be open to the these different strategies for solving problems.

When solving Improving to Level 5 problems, encourage learners to employ the following strategy:

1. Read the problem carefully two times.
2. Underline the question in the problem. Ask yourself, "What am I looking for in this problem?"
3. Circle all the relevant information. Ask yourself, "Is this all the information I need to solve the problem?"
4. Cross out all the unnecessary information. Ask yourself, "Is this information needed to solve the problem?"
5. Draw a diagram or picture to aid in visualizing the problem, if appropriate.
6. Decide which steps to perform and the order in which to perform them.
7. Solve the problem by carefully calculating the answer.

8. Check to be sure that you answered the question that was asked.

9. Check the answer in two of the following ways to see if it is reasonable.
    - Ask yourself, "Does my answer make sense?"
    - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
    - Make a mental estimation.

Problem 5.1: Factory Parts

LEARNER PAGE

Your factory builds parts. The manufacture of each part takes the following bolts:

6 3mm bolts per part
8 4mm bolts per part
10 9mm bolts per part

The schedule for the next year is to build 50 parts per shift, Monday through Friday. There are two shifts. How many bolts must your company purchase to support this production schedule?

A. 78,000
B. 780,000
C. 26,400
D. 624,000

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Improving To Level 5

Problem 5.1: Factory Parts

INSTRUCTOR'S GUIDE

Problem

Your factory builds parts. The manufacture of each part takes the following bolts:

6 3mm bolts per part
8 4mm bolts per part
10 9mm bolts per part

The schedule for the next year is to build 50 parts per shift, Monday through Friday. There are two shifts. How many bolts must your company purchase to support this production schedule?

A. 78,000
B. 780,000
C. 26,400
D. 624,000

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes	Twelfth-Grade Proficiency Outcomes
1. Compute with whole numbers, fractions, and decimals.	Strand I: Arithmetic 2. Estimate answers, compute, and solve problems involving real numbers. Strand IV: Algebra/Functions 8. Translate verbal statements into symbolic language.

Information Needed

Number of bolts per part
Number of parts to build for the next year

Skills Needed

Addition and multiplication

Solution Method 1

6 + 8 + 10 = 24 bolts per part

50 (per shift) x 2 (shifts per day) x 5 (days) x 52 (weeks) = 26,000 parts

24 (bolts per part) x 26,000 (parts) = **624,000** bolts

Solution Method 2

6 x (50 x 2 x 5 x 52 = 6 x 26,000 = 156,000

8 x (50 x 2 x 5 x 52) = 8 x 26,000 = 208,000

10 x (50 x 2 x 5 x 52) = 10 x 26,000 = 260,000

624,000

Estimation

6 rounds up to 10; 8 rounds up to 10; 10 rounds to 10

10 + 10 + 10 = 30

30 x 26,000 = 780,000

Answer

624,000

Notes:

Problem 5.2: Safety Shoes

LEARNER PAGE

On the first of the month you ordered safety shoes for work costing $65.49. The sales tax rate is 7%. The shoes were delivered this morning and you have $75.30 in your pocket. After paying for your safety shoes, how much money will you have left for lunch?

A. $5.88
B. $4.74
C. $5.23
D. $9.81

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.2: Safety Shoes

INSTRUCTOR'S GUIDE

Problem

On the first of the month you ordered safety shoes for work costing $65.49. The sales tax rate is 7%. The shoes were delivered this morning and you have $75.30 in your pocket. After paying for your safety shoes, how much money will you have left for lunch?

A. $5.88

B. $4.74

C. $5.23

D. $9.81

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Cost of shoes
Sales tax rates
Amount of money in pocket

Skills Needed

Multiplication, addition, subtraction of decimals
How to calculate sales tax

Solution Method 1

$65.49 (cost)	$65.49	$ 75.30
x .07 (%)	+ 4.58	– 70.07
$ 4.58 tax	$70.07 total cost	**$ 5.23** left for lunch

Solution Method 2

$65.49	$75.30
x 1.07	– 70.07
$70.07 total cost	**$ 5.23** left for lunch

Solution Method 3

$75.30 – ($65.49 x 1.07) = **$5.23**

Estimation

$65.49 rounds up to $70

$70 x 7% = 4.90

$70 + $4.90 = $74.90 which rounds up to $75

$75 – $70 = $5

Answer

$5.23

Notes:

186

Problem 5.3: Yellow Ribbons

LEARNER PAGE

You decorated your yard for a welcome home party. You decided to tie yellow ribbons around the four oak trees in your yard. One of the trees had a diameter of 2 ft. If you needed 12 in of ribbon for the bow, how much ribbon did you need to go around the 2-ft tree, including the bow? (Express your answer in feet.)

INFORMATION NEEDED:

(If you're drawing a diagram, include this information in your drawing.)

DRAWING SPACE:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.3: Yellow Ribbons

INSTRUCTOR'S GUIDE

Problem

You decorated your yard for a welcome home party. You decided to tie yellow ribbons around the four oak trees in your yard. One of the trees had a diameter of 2 ft. If you needed 12 in of ribbon for the bow, how much ribbon did you need to go around the 2-ft tree, including the bow? (Express your answer in feet.)

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
10. Find the perimeters (circumferences) and areas of polygons (circles).
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

4. Estimate and use measurements.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Diameter of the tree
Amount of ribbon needed for bow

Skills Needed

Addition, multiplication, and division
Separate extraneous information from needed information
Recognize and make correct substitutions in circumference formula
Calculate using multiple units

Solution Method 1

Bow uses 12 in or 1 ft of ribbon
Circumference is 2 x 3.14 = 6.28 ft
Total 6.28 ft + 1 ft = **7.28** ft

Solution Method 2

Diameter = 2 ft or 24 in
Circumference = 24 x 3.14 = 75.36 in
Total 75.36 + 12 = 87.36 in
Convert to ft: 87.36 ÷ 12 = **7.28** ft

Solution Method 3

Algebraic form
(2 ft x 3.14) + 1 ft = **7.28** ft

Estimate

Circumference: 2 x 3 = 6 ft
Total 6 + 1 = 7 ft

Answer

7.28 ft

Notes:

Problem 5.4: Wage Increase

LEARNER PAGE

Our factory's starting wage is $12.04. Next year on August 15 our wages increase by 3%. The year after next the increase will be another 3%. The year after that the increase will be 1.5%. What will the starting wage be 3 years from now?

A. $12.77
B. $12.40
C. $12.94
D. $12.96

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.4: Wage Increase

INSTRUCTOR'S GUIDE

Problem

Our factory's starting wage is $12.04. Next year on August 15 our wages increase by 3%. The year after next the increase will be another 3%. The year after that the increase will be 1.5%. What will the starting wage be 3 years from now?

A. $12.77
B. $12.40
C. $12.94
D. $12.96

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

Information Needed

Starting wage of $12.04
Percent increase for each year
Amount of money in pocket

Skills Needed

Addition and multiplication
Percents

Solution Method 1

12.04 x 3% = .36 .36 + 12.04 = 12.40

12.40 x 3% = .37 .37 + 12.40 = 12.77

12.77 x 1.5% = .19 .19 + 12.77 = **12.96**

Solution Method 2

12.04 x .03 = .36 .36 + 12.04 = 12.40

12.40 x .03 = .37 .37 + 12.40 = 12.77

12.77 x .015 = .19 .19 + 12.77 = **12.96**

Estimation

$12.04 rounds to $12.00

3% rounds to 5% $12.00 x 5% = .60 + 12.00 = $12.60

3% rounds to 5% $12.60 x 5% = .63 + 12.60 = $13.23

1.5% rounds to 0%

Answer

$12.96

Notes:

194

Problem 5.5: Building Materials

LEARNER PAGE

John is buying some additional building materials to finish a job. The lumber totals $110.65, the bricks total $86.80, and the nails total $15.25. Due to a sale, he will receive a 15% discount on the lumber and bricks. What is the total cost of the materials including 6% sales tax?

A. $194.06

B. $191.64

C. $188.66

D. $180.80

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.5: Building Materials

INSTRUCTOR'S GUIDE

Problem

John is buying some additional building materials to finish a job. The lumber totals $110.65, the bricks total $86.80, and the nails total $15.25. Due to a sale, he will receive a 15% discount on the lumber and bricks. What is the total cost of the materials including 6% sales tax?

A. $194.06

B. $191.64

C. $188.66

D. $180.80

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Cost of materials
Amount of discount
Amount of sales tax

Skills Needed

Addition, subtraction, multiplication with decimals
Calculate discount
Calculate sales tax

Solution Method 1

$110.65 + $86.80 = $197.45 (total)

$197.45 x .15 = $29.62 (discount)

$197.45 – $29.62 = $167.83 (total)

$167.83 + $15.25 = $183.08

$183.08 x .06 = $10.98 (tax)

$183.08 + $10.98 = **$194.06** (cost)

Solution Method 2

$110.65 + 86.80 = $197.45

$197.45 x .85 (which is 100% –15% discount) = $167.83

$167.83 + 15.25 = $183.08 (which is the material cost)

$183.08 x 1.06 = **$194.06** (which is cost +6% tax)

Solution Method 3

[(110.65 – (.15 x 110.65) + (86.80 – (.15 x 86.80) + 15.25] x 1.06 = **$194.06**

Estimation

Round $110.65 to $100 and $86.80 to $90

(100 + 90) x .15 = 28.50

190 — 28.50 = 161.50

Round to $160

(160 + 15) x .06 = 10.50

175 + 10.50 = 185.50

Answer

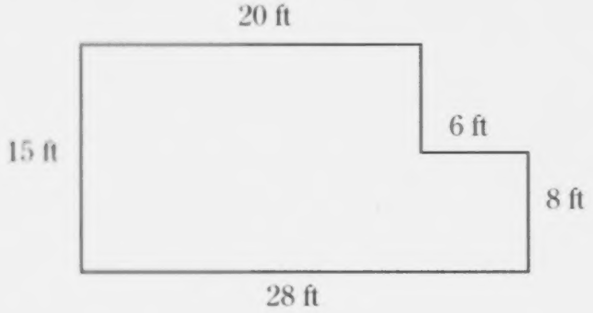
$194.06

Notes:

Problem 5.6: Floor Tiles

LEARNER PAGE

Look at the floor plan below. You have been hired to cover the floor with tiles. Each tile is 9 in x 9 in. How many tiles will you need to cover the floor?



A. 400 tiles
B. 560 tiles
C. 662 tiles
D. 5,952 tiles

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.6: Floor Tiles

INSTRUCTOR'S GUIDE

Look at the floor plan below. You have been hired to cover the floor with tiles. Each tile is 9 in x 9 in. How many tiles will you need to cover the floor?

A. 400 tiles
B. 560 tiles
C. 662 tiles
D. 5,952 tiles

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement
3. Determine area and volume.

Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

Information Needed

Area of floor
Area of tile

Skills Needed

Addition, subtraction, multiplication, and division
Rounding up

200

Solution Method 1

Draw a line on the diagram to form two rectangles.
Determine the area of those rectangles.
Add together the areas of the two rectangles.

20 ft	15 ft	8 ft	300 sq ft
x15 ft	−6 ft	x9 ft	+72 sq ft
300 sq ft	9 sq ft	72 sq ft	372 sq ft

Convert the area needed to be covered by tile from sq ft to sq in.
Determine the area of each tile.
Calculate the number tiles that will cover the floor in sq in.
Round the number of tiles to the next highest whole number.

144 sq in = 1 sq ft

372 sq ft x 144 sq in = 53,568 sq in

9 x 9 = 81 sq in

53,568 ÷ 81 = 661.33

661.33 = 662 tiles

Estimation

20 ft rounds to 20 ft; 15 ft rounds to 15 ft; 8 ft rounds to 10 ft; 9 ft rounds to 10 ft

15	10	300	144
x20	x10	+100	x 400
300	100	400 sq ft	57,600

57,600 ÷ 81 = 711.11

711.11 = 712 tiles

Answer

662 tiles

Notes:

202

Problem 5.7: Paint

LEARNER PAGE

You have decided to paint your rectangular room and know that one gallon of paint will cover 130 sq ft. Your room is 12 ft 6 in long, 10 ft 8 in wide and 9 ft high. How many gallons will you need to paint the walls and ceiling of your room with one coat of paint?

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.7: Paint

INSTRUCTOR'S GUIDE

Problem

You have decided to paint your rectangular room and know that one gallon of paint will cover 130 sq ft. Your room is 12 ft 6 in long, 10 ft 8 in wide and 9 ft high. How many gallons will you need to paint the walls and ceiling of your room with one coat of paint?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

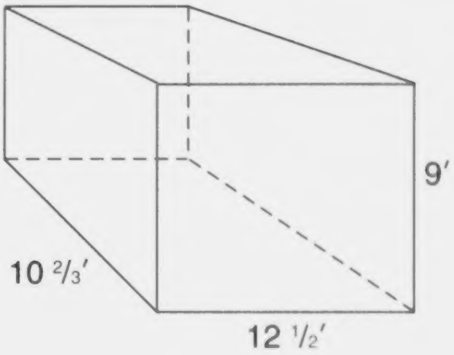
Dimension of the room
Coverage of 1 gallon of paint

Skills Needed

Area of rectangle using formula
Surface area
Addition, multiplication and division of decimals and whole numbers

Solution Method 1

12 ft 6 in = $12\frac{1}{2}$ ft   10 ft 8 in = $10\frac{2}{3}$ ft



$12\frac{1}{2}$ ft x 9 x 2 = 225 ft^2

$10\frac{2}{3}$ ft x 9 x 2 = 192 ft^2

$10\frac{2}{3}$ ft x $12\frac{1}{2}$ ft = 133 ft^2

Total = $550\frac{1}{3}$ ft^2

550.3 4 130 = 4.23 qt = 1 ¼ gal

Solution Method 2

($12\frac{1}{2}$ + $10\frac{2}{3}$) x 9 x 2 = 417 ft^2

$10\frac{2}{3}$ x $12\frac{1}{2}$ = $133\frac{1}{3}$ ft^2

$550\frac{1}{3}$ ft^2

550.3 ÷ 130 = 4.23 qt = **1 ¼ gal**

Solution Method 3

12 ft 6 in = 150 in

10 ft 8 in = 128 in

9 ft = 108 in

150 in x 108 in x 2 = 32,400 in^2

128 in x 108 in x 2 = 27,648 in^2

128 in x 150 in = 19,248 in^2

79,296 in^2

130 ft^2 x 144 in^2/ft^2 = 18,720 in^2

79,296 ÷ 18,720 = 4.2 = **1 ¼ gal**

Estimation

Round 12 ft 6 in to 13 ft

Round 10 ft 8 in to 11 ft

13 ft x 9 ft x 2 = 234 ft^2
11 ft x 9 ft x 2 = 198 ft^2
11 ft x 13 ft = 143 ft^2
575 ft^2

575 ÷ 130 = 4.4 = 1 ½ gal

Answer

1 ¼ gal

Problem 5.8: New Product

LEARNER PAGE

Our company has just introduced a new product in a basic model and a deluxe model. To be successful, we must have gross sales of $13,000 which includes a 15% profit. Our goal is to sell 100 of the deluxe models and 500 of the basic models. The price of the deluxe model is $10.00 more than the price of the basic model. How much does each model cost?

Basic model: $_________

Deluxe model: $_________

INFORMATION NEEDED:

Select the appropriate **FORMULA**:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.8: New Product

INSTRUCTOR'S GUIDE

Problem

Our company has just introduced a new product in a basic model and a deluxe model. To be successful, we must have gross sales of $13,000 which includes a 15% profit. Our goal is to sell 100 of the deluxe models and 500 of the basic models. The price of the deluxe model is $10.00 more than the price of the basic model. How much does each model cost?

Basic model: $__________

Deluxe model: $__________

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Gross sales
Number of deluxe models sold
Number of basic models sold
Deluxe model costs $10.00 more than the basic model

Skills Needed

Separate extraneous information from needed information
Addition, subtraction, division of whole numbers
Ability to calculate using an unknown quantity

Solution Method 1

x = price of basic model
x + 10 = price of deluxe model

$$\begin{aligned}
500x + 100(x + 10) &= 13{,}000 \\
500x + 100x + 1000 &= 13{,}000 \\
600x + 1000 - 1000 &= 13{,}000 - 1000 \\
600\,x &= 12{,}000 \\
x &= \textbf{\$20 basic} \\
x + 10 &= \textbf{\$30 deluxe}
\end{aligned}$$

Solution Method 2

100 deluxe models x $10 more in cost = $1000 more in sales for deluxe
13,000 – 1000 = $12,000 left

12,000 ÷ (500 basic + 100 deluxe) = **$20 basic**
20 + 10 = **$30 deluxe**

Estimation

After you find the answer, see if it fits the facts.

Answers

$20 basic
$30 deluxe

Notes:

Problem 5.9: Constructing a Building LEARNER PAGE

You will be constructing a 40 ft x 80 ft building that will be used as a warehouse. You need to create a list of materials to help determine the construction cost. Calculate the following information and make a materials list. Round all figures two places to the right of the decimal.

HINT: Draw a picture for each question. Underline necessary information. After solving each problem, check to see if your answer is reasonable.

---

1. The building will have a concrete footer under all four sides. The dimensions are 3 ft deep and 10 in wide all the way around the building. How much concrete will be needed for the footer?

2. This building will have a 4 in thick concrete floor. How much concrete will be needed?

$$\left(\text{cu yd} = \frac{\text{length in ft} \times \text{width in ft} \times \text{thickness in ft}}{27}\right)$$

3. One side of the building will be made with concrete blocks. This side is 40 ft long and 16 ft high. How many blocks will you need? Blocks are 1 ft 4 in x 8 in x 8 in in size. How much mortar and sand will be needed? (For every 40 standard blocks, 1 bag of mortar and 200 lb of sand are needed.)

4. One side of the building will be covered with wood siding. This siding is 8 in wide and 16 ft long. How many boards will you need to cover one 80 ft side?

5. The third side of the building will be covered with metal siding. Each sheet will cover an area that is 2 ft wide and 16 ft long. How many sheets will it take to cover an 80 ft side?

Problem 5.9: Constructing a Building **INSTRUCTOR'S GUIDE**

You will be constructing a 40 ft x 80 ft building that will be used as a warehouse. You need to create a list of materials to help determine the construction cost. Calculate the following information and make a materials list. Round all figures two places to the right of the decimal.

1. The building will have a concrete footer under all four sides. The dimensions are 3 ft deep and 10 in wide all the way around the building. How much concrete will be needed for the footer?

2. This building will have a 4 in thick concrete floor. How much concrete will be needed? (The formula for this calculation is: $\text{cu yd} = \dfrac{\text{length in ft} \times \text{width in ft} \times \text{thickness in ft}}{27}$)

3. One side of the building will be made with concrete blocks. This side is 40 ft long and 16 ft high. How many blocks will you need? The size of the blocks is 1 ft 4 in x 8 in x 8 in. How much mortar and sand will be needed? (For every 40 standard blocks, 1 bag bag of mortar and 200 lb of sand are needed.)

4. One side of the building will be covered with wood siding. This siding is 8 in wide and 16 ft long. How many boards will you need to cover one 80 ft side?

5. The third side of the building will be covered with metal siding. Each sheet will cover an area that is 2 ft wide and 16 ft long. How many sheets will it take to cover an 80 ft side?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.
4. Estimate and use measurements.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Formulas for area and volume
Dimensions of surfaces
Amount of block needed for each quantity of sand and mortar

Skills Needed

Using formulas for area and volume
Rounding

Solution Method

1. 10 in ÷ 12 in per ft = .833 ft

$$\frac{\text{240 ft long (all four sides) x .833 ft wide x 3 ft deep}}{27} = \frac{599.76}{27} = \mathbf{22.21\ cu\ yd} \text{ of concrete}$$

2. 4 in ÷ 12 in per ft = .333 ft

$$\frac{\text{80 ft long x 40 ft wide x .333 ft deep}}{27} = \frac{1065.60}{27} = \mathbf{39.46\ cu\ yd} \text{ of concrete}$$

3. 1 ft 4 in = 16 in

40 ft long x 12 in per foot = 480 in ÷ 16 in per block = 30 blocks per row

16 in tall x 12 in per foot = 192 in ÷ 8 in per block = 24 rows of blocks

24 x 30 = **720 blocks**

720 ÷ 40 = **18 bags** of mortar

18 x 200 = **3600 lb** of sand

4. 80 ft long x 12 in per foot = 960 in

960 in ÷ 8 in per board = **120 boards** that are 16 ft long

5. 80 ft long ÷ 2 ft per sheet width = **40 sheets** that are 16 ft long

Answers

(See the solution method above.)

Problem 5.10: New Car

LEARNER PAGE

You want to buy a new car. You find the same model car at two different dealerships with exactly the same sticker price: $14,690.25. *Joe's Discount Auto* offers you 7% off the sticker price. *Autotown* is giving a $1,500 rebate with each new car purchase. Which dealership is giving you the best deal (or cheaper price)? How much will you save over the more expensive dealership?

INFORMATION NEEDED:

SOLVE:

CHECK your work with an estimation. Is your answer reasonable?

Problem 5.10: New Car

INSTRUCTOR'S GUIDE

Problem

You want to buy a new car. You find the same model car at two different dealerships with exactly the same sticker price: $14,690.25. Joe's Discount Auto offers you 7% off the sticker price. Autotown is giving a $1,500 rebate with each new car purchase. Which dealership is giving you the best deal (or cheaper price)? How much will you save over the more expensive dealership?

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Sticker price
Joe's discount price
Autotown's discount price

Skills Needed

Subtraction
Calculation of percentages

Solution Method

Find the price of *Joe's* car as follows:
$14,690.25 – (.07 x 14,690.25) = $13,661.93
7% of $14,690.25 = $1,028.32

Find the price of *Autotown's* car as follows:
$14,690.25 – $1,500 = $13,190.25

The difference is $13,661.93 – $13,190.25 = **$471.68**

***Autotown* is cheaper.**

Estimation

10% off the sticker price of $14,690.25 = $1,469 which is less than the $1,500 rebate offered by *Autotown*.

Answer

Autotown is the cheapest; you will realize a savings of $471.68 if you buy from them.

Notes:

Improving to Level 6 INDEX

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About Level 6 Problems

Level 6 learners can

1. Perform applications described in the previous levels.
2. Solve complicated, multiple-step problems that may require manipulation of the original information. To solve Level 6 problems, workers may need to reorder information, eliminate extraneous information, and perform several-step conversions.
3. Calculate using negative numbers, fractions, ratios, percentages, and mixed numbers. Workers often need to multiply and divide fractions with unlike denominators and find reverse percentages. In addition, ratios may involve conversion of units within one system (e.g., 1 quart = 32 ounces).
4. Calculate multiple rates, then compare the rates or use them to perform other calculations. Level 6 workers often must use this these types of calculation skills to solve problems that involve production rates and pricing strategies. These problems might also involve conversions.
5. Find the areas of rectangles and volumes of rectangular solids. In the workplace, such problems require workers to transpose a formula before making calculations or to use two formulas to change from one unit to another unit within the same system of measurement.
6. Calculate multiple-step problems to determine the "best buy" and use the result in another problem.
7. Find mistakes in calculations. (This skill is required in workplace troubleshooting.) For example, Level 6 workers should be able locate mistakes in Level 3-5 problems.

Characteristics of Level 6 problems

- Involve tasks that are more complex in the number of calculations required and in the wording and organization of the problems
- Typically involve proportions, percentages, and averages
- Require the application of measurements to solve problems that involve conversions

Notes:

Instructional Strategies for Helping Learners Improve to Level 6

Using the practice problems in Targets for Learning is not enough to teach learners to solve math-related workplace problems. **Instructors need to provide learners with hands-on learning experiences**. In most cases, it is important to conduct hands-on learning activities **before** having learners solve the problems in *Targets for Learning*.

This section begins with suggested hands-on learning activities. These activities can be modified to create additional activities and practice problems. Instructors may also wish to use some of the resources listed in Appendix B as a basis for developing other learning opportunities for improving to Level 6 learners. In addition, refer to *Targets for Instruction*, pp. 61-71, for instruction suggestions specific to learners who are improving to Level 6.

When developing practice problems, remember that Level 6 problems are complex, involve multiple steps and include extraneous information. Be sure that you include them in learning activities and practice problems. Level 6 problems often involve proportions, percentages, and averages. Level 6 workers are also required to apply measurements to make conversions when solving problems.

The teachers and industry trainers who wrote this book encourage instructors to provide learners with a variety of hands-on activities, including the following:

Volume and Converting Measurements

Conduct the following learning activity:

1. Bring in food boxes, cans, and several balls.
2. Set up a separate lab station for each item.
3. Place metric measuring tools at some stations and English tools at others. Place Vernier calipers at the ball and cylinder stations.
4. Each station should be equipped with formula sheets and calculators.
5. Have learners rotate individually or in pairs through the stations, taking the necessary measurements to calculate volumes.
6. Halfway through the activity, change the metric tools to the English stations and vice versa.

7. After they have visited all stations and calculated volumes based on the tool there, ask learners to make the appropriate conversions to English or metric—so they have a metric and an English volume for each item (even though only one was derived by direct measurement).

8. To explore the concept of reasonable variance, have learners check the conversions by comparing their answers (which were based on actual measurements) with those of classmates.

Area and Converting Measurements

Repeat the activity described above, except this time, compute surface areas.

Diagraming Area

Drawing floor plans or wall plans is an important sub-skill of calculating area. At the beginning of class, have learners generate a drawing that is based on your verbal instructions. Then have them discuss their efforts.

Percent of Change

To explore percent of growth, bring the financial section of *The Wall Street Journal* to class for several days. Let learners pick several mutual funds, look at the percent of growth, and then calculate what an initial investment at the beginning of the year (e.g., $1500, $5000) would currently be worth.

Using Graphs

Clip statistical graphs and charts from *USA Today*. (They appear in the corner front page of almost each section.) Give each group of 2-4 learners a graph. Have each group develop five questions that can be answered using the graph; at least two questions must require some type of calculation to find the answer. Instruct each group to pass their graph and questions to another group to answer.

Volume and Percent Error

Conduct the following learning activity:

1. Have learners find the volumes of various solids in a square cm by taking measurements and calculating.
2. Then have learners find the solid volumes by using water displacement. (Since 1 ml = 1 sq cm, learners can see that the calculated and experimental values should be the same or close.)
3. Have learners find the percent error between calculated and experimental values.

Percentage and Ratios

Use the "best buy" practice problems in Level 5 to find the percent of discount, unit cost, and cost per unit.

Ratios

Provide learners with empty food packages. Have them calculate the grams of fat per serving information (e.g., calculate the amount consumed if you eat 1 $^3/_4$ servings).

Ask learners to calculate ratios used in standard photograph enlargements.

Have learners create and read scale drawings.

Have learners mix fertilizer, concrete, paint, and similar common substances.

Perimeter

Have learners determine the amount of tape needed to reinforce a box of specific dimensions.

Teach learners to calculate the amount of sealant needed to caulk windows of specific dimensions.

Give learners the opportunity to outline a patio with plants. Using the recommended spacing, ask them to calculate the number of plants that should be purchased.

Have learners determine the amount of fencing that will be needed to surround a swimming pool.

Negative Numbers

Provide learners with practice calculating with negative numbers. Real-life examples that involve negative numbers include thermometer temperatures, gauge readings, checking accounts transactions, debit sheet transactions, sea level and elevation readings, and football yardage.

Volumes

Take learners to a swimming pool where they can take measurements and calculate the pool's volume. (In real-life settings, such calculations are used to set up proper water treatment.) Note that this task can be challenging when there is a gradual change from the shallow to the deep ends.

Area and Ratios

Use aerial photographs with a scale to compute various areas (e.g., parking lots, lawns, golf greens).

Projects That Provide Hands-on Experience

Develop projects or problems that are centered around a specific business or trade. If appropriate, use the problems provided in Appendix C, pp. 327-338, or develop your own. You could also ask a volunteer from your local area to provide actual and typical problems from his or her business.

Notes:

Practice Problems for Improving to Level 6

Each of the following problems begins with a Learner Page, which presents a problem for learners to solve and, in some cases, guides learners through the problem-solving process. Each Learner Page is followed by an Instructor's Guide, which includes—

- The problem, as stated in the Learner Page
- Information needed to solve the problem
- Skills needed to solve the problem
- Ohio mathematics proficiency outcomes that pertain to the problem
- One or more methods for solving the problem
- A method for checking the answer through estimation

Refer to a comprehensive list of suggestions for using these practice problems in the sections titled Where Do I Begin? and How Should I Structure Learning Activities? on pp. 23-33.

In almost all cases, there is more than one way to solve a math problem. The teachers and industry trainers who wrote these problems provided more than one solution method when appropriate. In addition, learners may discover or explore approaches that are not described in this book. Instructors are encouraged to be open the these different strategies for solving problems.

When solving Improving to Level 6 problems, encourage learners to employ the following strategy:

1. Read the problem carefully two times.
2. Underline the question in the problem. Ask yourself, "What am I looking for in this problem?"
3. Circle all the relevant information. Ask yourself, "Is this all the information I need to solve the problem?"
4. Cross out all the unnecessary information. Ask yourself, "Is this information needed to solve the problem?"
5. Draw a diagram or picture to aid in visualizing the problem, if appropriate.
6. Decide which steps to perform and the order in which to perform them.

7. Solve the problem by carefully calculating the answer.

8. Check to see that each step of your calculation is correct and that you have answered the question that was asked.

9. Check the answer in two of the following ways to see if it is reasonable.
   - Ask yourself, "Does my answer make sense?"
   - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
   - Make a mental estimation.

Problem 6.1: Wallpaper

LEARNER PAGE

You have decided to wallpaper your rectangular room. The dimensions are 12 ft 6 in x 8 ft 6 in x 8 ft 0 in high. The room has two windows, each 4 ft 0 in x 2 ft 6 in and a door 7 ft 0 in x 3 ft 0 in. Determine how many rolls of wallpaper are needed to cover the walls, allowing 10% for matching and waste. Each roll of wallpaper is 30 in wide and 25 ft long. How many rolls of wallpaper should be purchased?

A. 5 rolls
B. 6 rolls
C. 7 rolls
D. 8 rolls
E. 9 rolls

DRAWING SPACE:

NEEDED INFORMATION: (Be sure needed information is included in your drawing.)

Select the appropriate **FORMULA**:

SOLVE:

CHECK your work with estimation. Is your answer reasonable?

Problem 6.1: Wallpaper

INSTRUCTOR'S GUIDE

Problem

You have decided to wallpaper your rectangular room. The dimensions are 12 ft 6 in x 8 ft 6 in x 8 ft 0 in high. The room has two windows, each 4 ft 0 in x 2 ft 6 in and a door 7 ft 0 in x 3 ft 0 in. Determine how many rolls of wallpaper are needed to cover the walls, allowing 10% for matching and waste. Each roll of wallpaper is 30 in wide and 25 ft long. How many rolls of wallpaper should be purchased?

A. 5 rolls
B. 6 rolls
C. 7 rolls
D. 8 rolls
E. 9 rolls

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

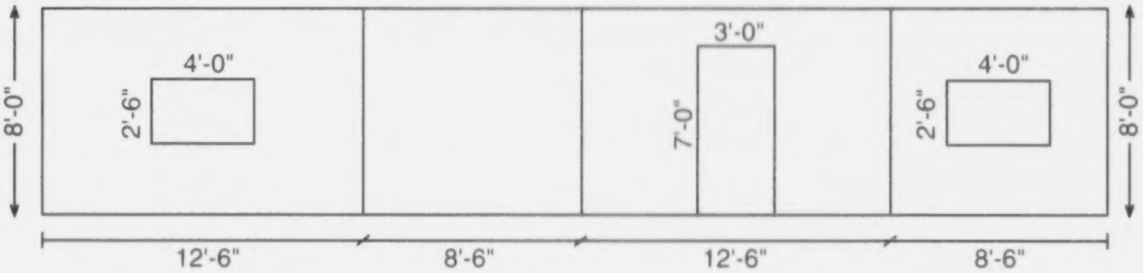
Information Needed

The room dimensions
The window and door dimensions
Decimal equivalents of inches to feet
The formula for calculating the area of a rectangle
The size of one roll of wallpaper

Skills Needed

Calculating areas
Multi-step calculations
Basic percentages

Solution Method



total wall area: 12 ft 6 in = 12.5 ft
8 ft 6 in = 8.5 ft
12 ft 6 in = 12.5 ft
8 ft 6 ft = 8.5 ft
42 ft x 8 ft = 336 ft^2

another way to calculate total wall area is:
12.5 ft x 8 ft x 2 = 200 ft^2
8.5 ft x 8 ft x 2 = 136 ft^2

1 roll: 30 in = 2.5 ft
2.5 ft x 2.5 ft = 62.5 ft^2 per roll

window area: 2 ft 6 in = 2.5 ft
2.5 in x 4 ft = 10 ft^2 x 2 windows = 20 ft^2

door area: 7 ft x 3 ft = 21 ft^2

area to be papered = total wall area – window area – door area

336 ft^2 – 20 ft^2 – 21 ft^2 = 295 ft^2

10% waste: .10 x 295 = 29.5 ft^2

324.5 ft^2 ÷ 62.5 ft^2 per roll = 5.192 rolls

Round up to **6 rolls**

Note: This problem can also be solved by converting all measurements to inches and then making the calculations described above.

Answer

6 rolls

Notes:

Improving to Level 6

Problem 6.2: CD Player

LEARNER PAGE

Five stores are selling the same CD player, but at different prices and offering different discounts. Stores B and C's sales will be offered for one week. Stores A, D, and E's sales will be offered for two weeks. Which store has the best buy?

Store A = $65.00 with a 15% discount
Store B = $75.00 with a 20% discount
Store C = $90.00 with a 30% discount followed by a 10% discount
Store D = $90.00 with a 25% discount
Store E = $85.00 with a 30% discount

Eliminate any unreasonable solutions before you solve the problem, if appropriate.

SOLVE:

CHECK your work with estimation. Is your answer reasonable?

Problem 6.2: CD Player

INSTRUCTOR'S GUIDE

Problem

Five stores are selling the same CD player, but at different prices and offering different discounts. Stores B and C's sales will be offered for one week. Stores A, D, and E's sales will be offered for two weeks. Which store has the best buy?

A. Store A = $65.00 with a 15% discount

B. Store B = $75.00 with a 20% discount

C. Store C = $90.00 with a 30% discount followed by a 10% discount

D. Store D = $90.00 with a 25% discount

E. Store E = $85.00 with a 30% discount

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
5. Solve problems and make applications involving percentages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Price of each CD player
Discount offered by each store

Skills Needed

Percent discounts
Multiple discount to determine the best buy

Solution Method 1

Store A: $65 x .15 = $9.75 $65 – $9.75 = **$55.25**

Store B: $75 x .20 = $15 $75 – $15 = $60

Store C: $90 x .30 = $27
$90 – $27 = $63
$63 x .10 = $6.30
$63 – $6.30 = $56.70

Store D: $90 x .25 = $22.50
$90 – $22.50 = $67.50
Some learners may immediately eliminate D since E is obviously a better choice.)

Store E: $85 x .30 = $25.50
$85 – $25.50 = $59.50

Solution Method 2

Store A: 100% – 15% off = 85% cost
$65 x 85% = **$55.25**

Store B: 100% – 20% off = 80% cost
$75 x 80% = $60.00

Store C: 100% – 30% = 70%
100% – 10% = 90%
$90 x 70% = $63 x 90% = $56.70

Store D: 100% – 25% = 75%
$90 x 75% = $67.50

Store E: 100% – 30% = 70%
$85 x 70% = $59.50

Solution Method 3

Another way to solve this problem is to develop a chart and use 10% of the selling price as the basis for figuring the discount. For example, the price at Store A is $65, less 10% discount (which is $6.50) plus half of 10% discount (which is $3.25) for a total of 15% discount.

	Selling Price	Less Discount	Price Off	Adjusted Total Price
Store A	$65	$6.50 + $3.25	$9.75	**$55.25**
Store B	$75	$7.50 + $7.50	$15.00	$60
Store C	$90	($9 + $9 + $9) = $27 x 10% = $6.30	$27 + 6.30 = $33.30	$56.70
Store D	$90	$9 + $9 + $4.50	$22.50	$67.50
Store E	$85	$8.50 +$8.50 + $8.50	$25.50	$59.50

Answer

Store A

Problem 6.3: Photocopy Machine

LEARNER PAGE

ABC Marketing, Inc. needs to purchase a new photocopy machine. One company would lease a copy machine at $150 per month plus charge 2.5 cents for individual copies. Another copier may be purchased on a 3-year payment plan for $10,300; individual copies would cost 1.5 cents. If the company plans to run 200,000 copies per year, which plan provides the better deal over 3 years and by how much?

A. The leased machine by $1,100
B. The purchased machine by $1,100
C. The leased machine by $900
D. The purchased machine by $900
E. The leased machine by $800

NEEDED INFORMATION:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 6.3: Photocopy Machine

INSTRUCTOR'S GUIDE

Problem

ABC Marketing, Inc. needs to purchase a new photocopy machine. One company would lease a copy machine at $150 per month plus charge 2.5 cents for individual copies. Another copier may be purchased on a 3-year payment plan for a total of $10,300; individual copies would cost 1.5 cents. If the company plans to run 200,000 copies per year, which plan provides the better deal over 3 years and by how much?

A. The leased machine by $1,100
B. The purchased machine by $1,100
C. The leased machine by $900
D. The purchased machine by $900
E. The leased machine by $800

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.
Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

Information Needed

The monthly lease cost and per copy charges
The purchase plan price and per copy charge
The total number of copies run per year

240

Skills Needed

Separating needed information from extraneous information
Multiplication
Comparing the best buy

Solution Method

One solutions is described below. Learners may find several different ways to solve this problem.

Leased Machine:

Lease price plus 3 yr copy charge

$150 x 12 mo x 3 yr = $5400

200,000 copies x 3 yr x $.025 = $15,000

Total cost = $20,400

Purchased Machine:

Purchase price for 3 yr plus copy charge

$10,300 + 200,000 copies x 3 yr x $.015 = $900

Total cost = $19,300

$20,400 – $19,300 = **$1,100 saved by purchasing a copy machine**

Answer

The purchased machine by $1,100

Notes:

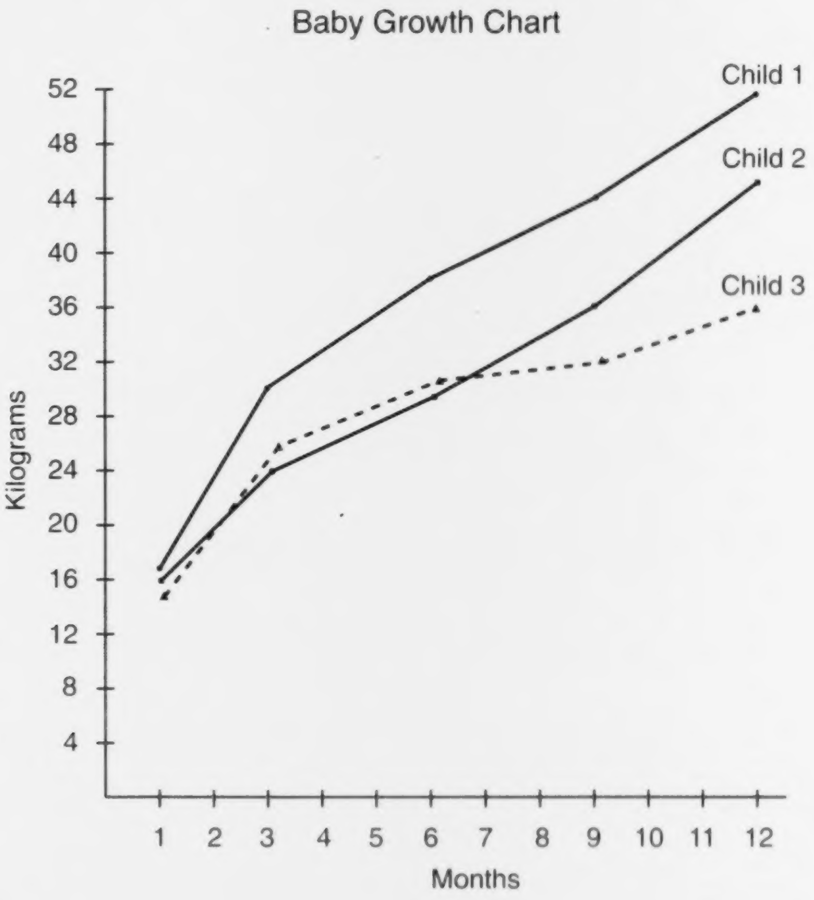
242

Problem 6.4: Weight of Babies

LEARNER PAGE

Your friend, Sheniqua, works in a pediatrician's office. Below is the graph of a weight growth chart for three different children. Sheniqua needs to calculate the average weight of the children at 12 months old. To the nearest pound, what was the average weight of the three children at 12 months old?

A. 15 pounds
B. 18 pounds
C. 19 pounds
D. 20 pounds
E. 21 pounds



NEEDED INFORMATION:

SOLVE:

CHECK your answer. Is it reasonable?

Problem 6.4: Weight of Babies

INSTRUCTOR'S GUIDE

Your friend, Sheniqua, works in a pediatrician's office. Below is the graph of a weight growth chart for three different children. Sheniqua needs to calculate the average weight of the children at 12 months old. To the nearest pound, what was the average weight of the three children at 12 months old?

A. 15 lb

B. 18 lb

C. 19 lb

D. 20 lb

E. 21 lb

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
12. Read, interpret, and use tables, charts, maps, and graphs to identify patterns, note trends, and draw conclusions.
14. Compute averages.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand III: Data Analysis

6. Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions.

Information Needed

The three weights from the growth chart at 12 months, as displayed on the graph kg-lb equivalents

Skills Needed

Finding values on a graph
Simple statistics to calculate the average
Conversion from kg to lb

Solution Method

Child 1	52 kg
Child 2	42 kg
Child 3	36 kg
	130 kg total ÷ 3 = 43.3 average

Convert from kg to lb:

2.2 kg = 1 lb
43.3 ÷ 2.2 = 19.69 lb
Round up to **20**, which is the nearest pound.

Answer

20 lb

Note to Instructors

Instructors could develop additional practice problems with this graph. For example, learners could be asked to take readings of all three children at 3, 6, 9, and 12 months and then determine which child has had the fastest and which has had the slowest rate of growth.

Problem 6.5: Carpeting

LEARNER PAGE

A dining room 15 ft wide and 21 ft long and a living room 18 ft wide and 30 ft long are to be carpeted. Jimmy's Carpet Co. charges $9.00 per square yard installed, while Carpet Connection charges $7.50 per square yard, plus a flat fee of $150.00 for installation. Which company gives you the better deal, and by how much?

A. Jimmy's by $7.50
B. Carpet Connection by $7.50
C. Jimmy's by $1132.50
D. Carpet Connection by $1132.50

DRAW the living room and dining room in the space below. Label the dimensions.

LIST NECESSARY INFORMATION:

SOLVE (Note the units you use):

CHECK your answer. Is it reasonable?

Problem 6.5: Carpeting

INSTRUCTOR'S GUIDE

A dining room 15 ft wide and 21 ft long and a living room 18 ft wide and 30 ft long are to be carpeted. Jimmy's Carpet Co. charges $9.00 per square yard installed, while Carpet Connection charges $7.50 per square yard, plus a flat fee of $150.00 for installation. Which company gives you the better deal, and by how much?

A. Jimmy's by $7.50

B. Carpet Connection by $7.50

C. Jimmy's by $28.50

D. Carpet Connection by $1132.50

E. Jimmy's by $1132.50

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

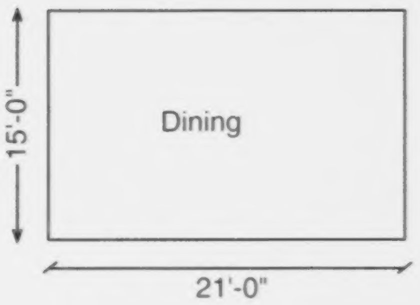
Information Needed

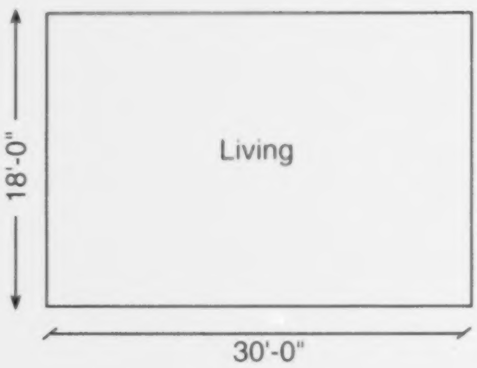
Dimensions
Square feet converted to square yards

Skills Needed

Calculating areas
Calculating costs to determine the best buy

Solution Method 1





Dining area = length x width
= 21ft x 15ft
= 315 ft^2

Living area = length x width
= 30 ft x 18 ft
= 540 ft^2

Total area = 315 ft^2 + 540 ft^2 = 855 ft^2

Convert square feet to square yards: 855 ft^2 ÷ 9 ft sq per yd^2 = 95 yd^2

Jimmy's: 95 yd^2 x \$9/yd^2= \$855

Carpet Connection: 95 yd^2 x \$7.50/yd^2 = \$712.50 + \$150 flat fee = \$862.50

Jimmy's is the better deal by \$7.50 (which is \$862.50 – \$855.00)

Solution Method 2

Convert dimensions to yards immediately before calculating area.

Answer

Jimmy's by \$7.50

Problem 6.8: Mutual Funds

LEARNER PAGE

Five people invested in different stocks. The chart below shows performances of the various investments since the beginning of the year. By determining the percent change, calculate which investment had the greatest return.

A. Roger
B. Nyssa
C. Maria
D. Margaret
E. Greg

Investment	December 31	Today Change	Percent
Roger	$187.00	$194.95	
Nyssa	2574.97	2378.65	
Maria	675.34	563.56	
Margaret	342.65	498.67	
Greg	2345.67	1975.24	

SOLVE:

CHECK your answer with estimation. Is your answer reasonable?

Problem 6.6: Mutual Funds

INSTRUCTOR'S GUIDE

Problem

Five people invested in different stocks. The chart below shows performances of the various investments since the beginning of the year. By determining the percent change, calculate which investment had the greatest return.

A. Roger
B. Nyssa
C. Maria
D. Margaret
E. Greg

Investment	December 31	Today	Percent Change
Roger	$187.00	$194.95	
Nyssa	2574.97	2378.65	
Maria	675.34	563.56	
Margaret	342.65	498.67	
Greg	2345.67	1975.24	

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, whole numbers, and integers.
5. Solve problems and make applications involving percentages.
12. Read, interpret, and use tables, charts, maps, and graphs to identify patterns, note trends, and draw conclusions.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Strand III: Data Analysis

6. Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions.

Information Needed

Value of each investor's mutual fund on December 31
Value of each investor's mutual fund today
Percent change of each investor's mutual fund from December 31 to today

Skills Needed

Calculating percent of increase
Reading and using a chart

Solution Method 1

$$\text{Percent change} = \frac{\text{current–original}}{\text{original}} \text{ x } 100\%$$

Roger:

$$\frac{194.95 - 187}{187} = \frac{7.95}{187} \div .043 \text{ x } 100 = 4.3\%$$

Nyssa:

$$\frac{2378.65 - 2574.97}{2574.97} = \frac{-196.32}{2574.97} = -.076 \text{ x } 100 \approx -7.6\% \text{ (not necessary to calculate obvious loss)}$$

Maria:

$$\frac{563.56 - 675.34}{675.34} = \frac{-111.78}{675.34} \approx -.166\text{x } 100 = 16.6\% \text{ (not necessary to calculate obvious loss)}$$

Margaret:

$$\frac{498.67 - 342.65}{342.65} = \frac{-156.02}{342.65} \approx -.455 \text{ x } 100 = -45.5\%$$

Greg:

$$\frac{1975.24 - 2345.67}{2345.67} = \frac{-370.43}{2345.67} \approx -.158 \text{ x } 100 = -15.8\% \text{ (another loss; no calculation necessary)}$$

Margaret has the greatest % increase.

Solution Method 2 (Estimation)

Estimation alone will simplify the calculation. Process of elimination early also helps, since Nyssa, Maria, and Greg obviously did not experience **any** increase; further calculations were not necessary.

Estimate only reasonable solutions.

Roger: $$\frac{195 - 187}{187} = \frac{8}{187} \approx .04 \times 100\% = 4\%$$

Margaret: $$\frac{499 - 343}{343} = \frac{156}{343} \approx .45 \times 100\% = 45\%$$

Margaret has the greatest % increase.

Answer

Margaret

Problem 6.7: Attic Insulation

LEARNER PAGE

You are building a 2-story house with 2,500 ft^2 of living space. You will need 14 ft^2 of attic insulation. You want the best possible insulation for your home. In addition, you need to stay within your $700 budget. The R-value, cost and area of your insulation options are as follows:

R-19 insulation costs $21 per roll and covers 75 ft^2

R-25 insulation costs $16.50 per roll and covers 34.5 ft^2

R-30 insulation costs $28 per roll and covers 55 ft^2

(Note: R-value refers to the thickness of the insulation; the higher the R-value, the thicker the insulation.)

How much of which insulation will you need to buy?

A. 20 rolls of R-19 insulation
B. 40 rolls of R-25 insulation
C. 41 rolls of R-25 insulation
D. 25 rolls of R-30 insulation
E. 26 rolls of R-30 insulation

NEEDED INFORMATION:

SOLVE (select the appropriate formula):

CHECK your answer. Is it reasonable?

Problem 6.7: Attic Insulation

INSTRUCTOR'S GUIDE

You are building a 2-story house with 2,500 ft^2 of living space. You will need 14 ft^2 of attic insulation. You want the best possible insulation for your home. In addition, you need to stay within your $700 budget. The R-value, cost and area of your insulation options are as follows:

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R-30 insulation costs $28 per roll and covers 55 ft^2

(Note: R-value refers to the thickness of the insulation; the higher the R-value, the thicker the insulation.)

How much of which insulation will you need to buy?

A. 20 rolls of R-19 insulation
B. 40 rolls of R-25 insulation
C. 41 rolls of R-25 insulation
D. 25 rolls of R-30 insulation
E. 26 rolls of R-30 insulation

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
2. Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.
4. Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

1. Compare, order, and determine equivalence of real numbers.
2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Dimensions of the attic
Total area per roll of each type of insulation
Cost per roll of each type of insulation
Total rolls of each type of insulation

Skills Needed

Calculating total cost
Calculating areas
Rounding (up)

Solution Method

Attic area = length x width
= 700 ft x 200 ft
= 1400 ft^2

Number of rolls needed
R-19 insulation = 1400 ft^2 x 75 ft^2 = 18.66 rolls (rounded up to 19 rolls)
R-25 insulation = 1400 ft^2 x 34.5 ft^2 = 40.58 rolls (rounded up to 41 rolls)
R-30 insulation = 1400 ft^2 x 55 ft^2 = 25.45 rolls (rounded up to 26 rolls)

Cost of insulation
R-19 insulation = 19 rolls x $21 = $399
R-25 insulation = 41 rolls x $16.50 = $676.50
R-30 insulation = 26 rolls x $28 = $728

With a budget of $700, you can afford **41 rolls of R-25 insulation**.

Answer

41 rolls of R-25 insulation

Problem 6.8: Chemical Applications

LEARNER PAGE

You must apply herbicides to your 420 acres of corn. Calculate the cost of the chemicals that will be applied.

You plan to apply one pre-emergence application of Bicep and Roundup and one post-emergence application of Banvel. The rates you will apply are as follows:

	Rate of Application	Cost
Roundup	24 oz per acre	$45.67 per gal
Bicep	2 qt per acre	$34.15 per gal
Banvel	8 oz per acre	$75.56 per gal

How much will it cost to apply all three chemicals?

A. $12,751.46

B. $7,171.50

C. $3,596.51

D. $10,768.01

Underline the **INFORMATION NEEDED** in the problem above.

SOLVE:

CHECK your answer. Is it reasonable?

Problem 6.7: Chemical Applications

INSTRUCTOR'S GUIDE

You must apply herbicides to your 420 acres of corn. Calculate the cost of the chemicals that will be applied.

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How much will it cost to apply all three chemicals?

A. $12,751.46
B. $7,171.50
C. $3,596.51
D. $10,768.01

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
7. Convert, compare, and compute with common units of measurement within the same measurement system.
11. Find surface areas and volumes of rectangular solids.
12. Read, interpret, and use tables, charts, maps, and graphs to identify patterns, note trends, and draw conclusions.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.

Strand IV: Algebra/Functions

8. Translate verbal statements into symbolic language.

Information Needed

Cost of each chemical
Number of acres
Total amount of each chemical

Skills Needed

Calculating total cost
Calculating areas
Calculating rates of application

Solution Method

Total area to which chemicals will be applied: 420 acres

Total gallons of each chemical:
Roundup 24 oz x 420 acre/128 oz = 78.75 gal
Bicep 2 qt x 420 acre /4 qt = 210 gal
Banvel 8 oz x 420 acre/128 oz = 26.25 gal

Cost of each chemical:
Roundup 78.75 gal x $45.67 = $3,596.51
Bicep 210 gal x $34.15 = $7,171.50
Banvel 26.25 gal x $75.56 = $1,983.45

Total chemical costs:
$3,596.51 + $7,171.50 + $1,983.45 = **$12,751.46**

Answer

$12,751.46

Note to Instructors

Instructors may wish to enhance this problem by providing learners with the following additions:

Calculate the per-acre chemical costs. (Solution: $30.35)

Your sprayer applies at a rate of 20 gal per acre. It holds 500 gal. You can cover 35 acres in an hour.

- How many total trips will you need to make to cover the entire field for both applications? (Solution: 33.6 loads, rounded to 34 loads)
- How many gallons of water will you need to spray the field? (Solution: 16,485 gal)
- How much time will it take for you to make both applications? (Solution: 24 hours)

Notes:

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MATHEMATICS

TARGETS FOR LEARNING

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Improving to Level 7

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About Level 7 Problems

Level 7 learners can

1. Perform applications described in the previous levels.
2. Do four or more steps of reasoning and multiple calculations.
3. Solve problems involving more than one unknown and/or nonlinear functions. For example, Level 7 workers may need to combine rates or mixtures.
4. Calculate the percentage of change. Level 7 workers often need to find the percentage of change in quantities (e.g., sales, inventory), measurement (e.g., temperature), and money (e.g., prices).
5. Calculate multiple areas and volumes of spheres, cylinders, and cones. Level 7 workers need to calculate areas and volumes of irregular shapes, which can be determined by breaking them down into regular shapes.
6. Set up and manipulate complex ratios and proportions. They may contain mixed units that require conversions.
7. Determine the best economic value of several alternatives. This often involves the use of graphics, finding a percentage difference, or calculating a unit cost.
8. Find mistakes in multiple-step calculations. (This is a skill required in workplace troubleshooting.) For example, Level 7 workers should be able locate mistakes in Level 3-6 problems.

Characteristics of Level 7 problems

- Include information that is complex, unclearly organized, and may be incomplete
- Require many steps of reasoning

Notes:

Instructional Strategies for Helping Learners Improve to Level 7

Using the practice problems in Targets for Learning is not enough to teach learners to solve complex math-related workplace problems. **Instructors need to provide them with opportunities to learn through hands-on experiences.** In most cases, it is important to conduct hands-on learning activities **before** presenting learners with the practice problems in *Targets for Learning*.

When helping learners improve to Level 7, instructors should provide them with hands-on activities that are related to the workplace. Level 7 does not introduce new mathematical concepts. It does, however, pose complex problems that include multiple steps and calculations. In addition, instructors may want to review the use of exponents. Instructors should also give learners practice at reading problems carefully and using complex reasoning to solve problems.

Instructors may also wish to use some of the resources listed in Appendix B as a basis for developing learning opportunities for Level 7 learners. In addition, refer to *Targets for Instruction*, pp. 72-85, for specific suggestion in providing instruction to Level 7 learners.

The following guidelines are provided for instructors who are developing hands-on learning activities for Level 7 Learners:

- Give learners opportunities to solve problems that have **more than one unknown**.

- Have learners practice calculating **area of irregular figures**. This might involve breaking down those areas into regular shapes such as squares, rectangles, and triangles. Puzzles such as tangrams can help learners visualize how regular shapes can be made into irregular ones.

- Have learners determine the **volume of spheres, cylinders, or cones** by filling everyday containers (e.g., tin cans, cylinders, barrels) with measured water.

- Give learners opportunities to calculate the **"best buy"** by calculating values, finding differences, finding the percent of differences, and calculating the unit cost or weight.

- Level 7 learning activities should include a **mixture of fractions, decimals, and differing units of measurements**.

- Level 7 learning activities can be similar to those assigned to lower-level learners, but should include problems that are **more complex** because they involve **more steps**, include **more extraneous information**, and/or are **stated less clearly**.

- Have learners **find errors in multiple-step calculations**. For example, learners can be asked to review problems that learners working at Levels 5 and 6 have solved. Learners should check whether or not the problem was set up correctly, conversions were done correctly, operations were done correctly, and decimals were placed correctly.

- Give learners **practice solving realistic workplace problems** by having them collect the information that would be needed to start a business or determine an existing business's effectiveness (e.g. calculate values of inventory, wholesale costs, retail sales).

- Have learners **analyze data** that involves percentage of change over time, such as data on sales, employment, and the U.S. population. Data is usually presented in graph form in some newspapers, including *USA Today*. In addition, data on demographics can be found on various Internet sites including www.http://stats.bls.gov.

- Some problems that can be used with Level 7 learners are provided in Appendix C, pp.327-338.

Practice Problems for Improving to Level 7

Each of the following problems begins with a Learner Page, which presents a problem for learners to solve and, in some cases, guides learners through the problem-solving process. Each Learner Page is followed by an Instructor's Guide, which includes—

- The problem, as stated in the Learner Page
- Information needed to solve the problem
- Skills needed to solve the problem
- Ohio mathematics proficiency outcomes that pertain to the problem
- One or more methods for solving the problem
- A method for checking the answer through estimation

Refer to a comprehensive list of suggestions for using these practice problems in the sections titled Where Do I Begin? and How Should I Structure Learning Activities? on pp. 23-33.

In almost all cases, there is more than one way to solve a math problem. The teachers and industry trainers who wrote these problems provided more than one solution method when appropriate. In addition, learners may discover or explore approaches that are not described in this book. Instructors are encouraged to be open the these different strategies for solving problems.

When solving Improving to Level 7 problems, encourage learners to employ the following strategy:

1. Read the problem carefully two times.
2. Underline the question in the problem. Ask yourself, "What am I looking for in this problem?"
3. Circle all the relevant information. Ask yourself, "Is this all the information I need to solve the problem?"
4. Cross out all the unnecessary information. Ask yourself, "Is this information needed to solve the problem?"
5. Draw a diagram or picture to aid in visualizing the problem, if appropriate.
6. Decide which steps to perform and the order in which to perform them.

7. Solve the problem by carefully calculating the answer.

8. Check to see that each step of the calculation is correct and that you have answered the question that was asked.

9. Check the answer in two of the following ways to see if it is reasonable.
    - Ask yourself, "Does my answer make sense?"
    - Check your calculation by performing the opposite operation (i.e., subtraction is the opposite of addition, multiplication is the opposite of division).
    - Make a mental estimation.

Improving to Level 7

Problem 7.1: Moving Water

LEARNER PAGE

A container, in the form of a cube, measures 2 ft on a side and is completely filled with water. If all the water is to be poured into cylindrical containers, each with a radius of 5 in and a height of 10 in, how many of these cylindrical containers is needed?

A. 16
B. 17
C. 18
D. 19
E. 20

DRAWING SPACE:

NEEDED INFORMATION:

SOLVE (be sure you're using the right formula):

CHECK your work. Does your answer make sense?

Problem 7.1: Moving Water

INSTRUCTOR'S GUIDE

Problem

A container, in the form of a cube, measures 2 ft on a side and is completely filled with water. If all the water is to be poured into cylindrical containers, each with a radius of 5 in and a height of 10 in, how many of these cylindrical containers is needed?

A. 16
B. 17
C. 18
D. 19
E . 20

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money.
10. Find the perimeters (circumferences) and areas of polygons (circles).
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement
3. Determine area and volume.

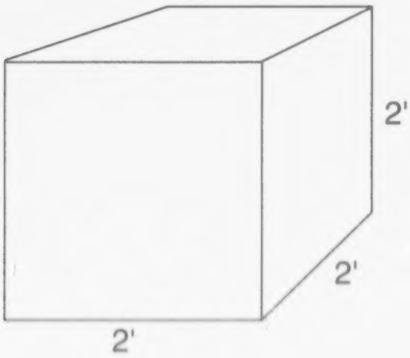
Information Needed

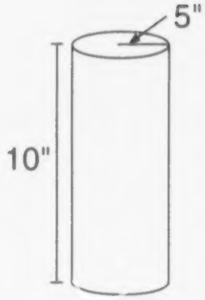
Formulas for solids

Skills Needed

Calculating volumes of solid areas
Reading a problem carefully to extract needed information

Solution Method 1





Volume of cube = (side)^3 = (2 ft)^3 = 8ft^3 or (24 in)^3 = 13,824 in^3

Volume of cylinder = 3.14 x (radius)^2 x height
= 3.14 x (5 in)^2 x 10 in
= 3.14 x 25 in^2 x 10 in
= 785 in^3

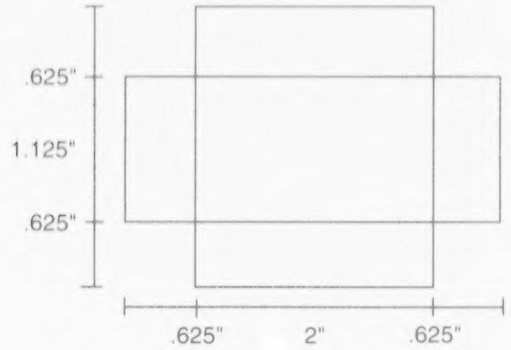
Cube volume ÷ cylinder volume = number of containers needed
12,824 in3 ÷ 785 in^3 = 17.61 containers
Round up **to 18 containers**

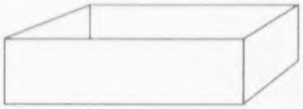
Answer

18 containers

Problem 7.2: Circuit Board Box LEARNER PAGE

Below is a print of a sheet metal part that is to be folded into a circuit board box:





Tolerances on all measurements are ± .005 in.

What is the percent change from the ideal volume if the minimum tolerance for each dimension is reached?

A. 1.5 %
B. 3 %
C. 5 %
D. 7.5 %
E. 10 %

DRAWING SPACE:

NEEDED INFORMATION:

SOLVE:

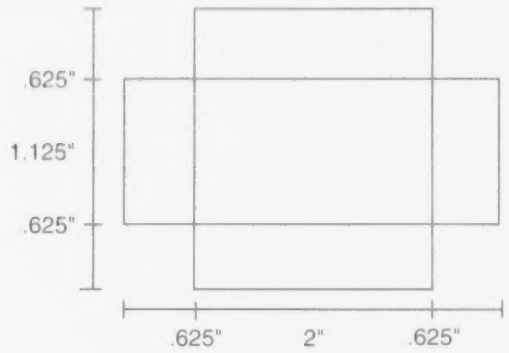
CHECK your work. Is your answer reasonable?

Problem 7.2: Circuit Board Box

INSTRUCTOR'S GUIDE

Problem

Below is a print of a sheet metal part that is to be folded into a circuit board box:



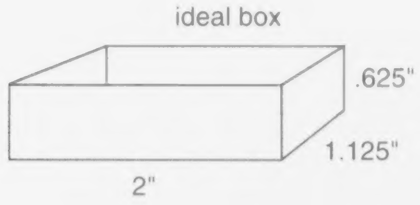
Tolerances on all measurements are ± .005 in.

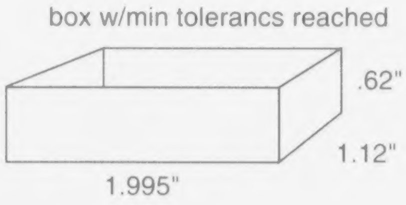
What is the percent change from the ideal volume, if the minimum tolerance for each dimension is reached?

- A. 1.5 %
- B. 3 %
- C. 5 %
- D. 7.5 %
- E. 10 %

Drawing Space

The ideal box would be: A box with minimum tolerances would be:





Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement

3. Determine area and volume.
17. Describe and apply the properties of similar and congruent figures.

Information Needed

The formula for calculating the volume of a box
An understanding of the definition of tolerances (A tolerance is the limit in which the actual measurement may vary and still be acceptable for its intended use. For example, in the above part, the length of the box could be as short as 1.995 in [2 in – .005 in] or as long as 2.005 in [2 in + .005 in] and still be accepted. Lengths outside that range would cause the part to be rejected. Learners may need a brief explanation of the concept of tolerance in order to understand this problem.)

Skills Needed

Reading a print
Using tolerances
Calculating volume of solids
Finding the percent change

Solution Method

$$\begin{aligned}\text{Volume of ideal box} &= \text{length x width x height}\\ &= 2\text{ in x }1.125\text{ in x }.625\text{ in}\\ &= 1.40625\text{ in}^3\end{aligned}$$

$$\begin{aligned}\text{Volume of min. box} &= \text{length x width x height}\\ &= 1.995\text{ in x }1.12\text{ in x }62\text{ in}\\ &= 1.385328\text{ in}^3\end{aligned}$$

$$\text{percent change} = \frac{\text{original} - \text{new}}{1.40625}\text{ x }100\%$$

$$= \frac{1.40625 - 1.385328}{1.40625} = \frac{.020922}{1.40625} \approx .0148\text{ x }100\% \approx 1.48\%\text{, rounded to }\mathbf{1.5\%}$$

Answer

1.5%

Notes:

Problem 7.3: Fish Tank

LEARNER PAGE

Your fish tank needs to be replaced. Its dimensions are 3 ft 0 in x 1 ft 6 in x 1 ft 3 in. The new tanks come only in metric sizes. Which of the following tanks is closest in size to your original tank?

A. .91m; 70cm; 38cm
B. .95m; 46cm; 40cm
C. .91m; 55cm; 38cm
D. .95m; 60cm; 40cm
E. .91m; 46cm; 38cm

NEEDED INFORMATION:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 7.3: Fish Tank

INSTRUCTOR'S GUIDE

Problem

Your fish tank needs to be replaced. Its dimensions are 3 ft 0 in x 1 ft 6 in x 1 ft 3 in. The new tanks come only in metric sizes. Which of the following tanks is closest in size to your original tank?

A. .91m; 70cm; 38cm
B. .95m; 46cm; 40cm
C. .91m; 55cm; 38cm
D. .95m; 60cm; 40cm
E. .91m; 46cm; 38cm

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes	Twelfth-Grade Proficiency Outcomes
1. Compute with whole numbers, fractions, and decimals. 7. Convert, compare, and compute with common units of measurement within the same measurement system.	Strand I: Arithmetic 1. Compare, order, and determine equivalence of real numbers.

Information Needed

The proper conversion formula
The correct volume formulas
1 ft = .3048 meters
1 meter = 100 centimeters

Skills Needed

Selecting and using formulas
Conversion from one measurement system to another system

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Solution Method

First dimension : 3 ft = .3048 = .9144 → eliminate solutions B and D

Second dimension: 1 ft 6 in or 1.5 ft = .3048 m x 1.5 = .4572 m x 100
To change to cm, multiply by 100
= 45.72 cm
Round to 46 cm
Stop here because **E is the only solution that fits**.

Answer

.91m; 46cm; 38cm

Notes:

Problem 7.4: Job Interview

LEARNER PAGE

You are traveling to Cincinnati for a job interview. You leave Cleveland at 7:45 a.m. and arrive in Columbus at 10:30 a.m. The distance from Cleveland to Columbus is 126 miles; the distance from Cleveland to Cincinnati is 235 miles. The speed limit is 65 mph. What is the minimum average speed you must maintain in order to arrive in Cincinnati before 1:15 p.m.?

A. 35 mph
B. 40 mph
C. 45 mph
D. 50 mph
E. 55 mph

Hint: use your formula sheet to determine the formula for calculating distance.

NEEDED INFORMATION:

DRAWING SPACE:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 7.4: Job Interview

INSTRUCTOR'S GUIDE

Problem

You are traveling to Cincinnati for a job interview. You leave Cleveland at 7:45 a.m. and arrive in Columbus at 10:30a.m. The distance from Cleveland to Columbus is 126 miles; the distance from Cleveland to Cincinnati is 235 miles. The speed limit is 65 mph. What is the average speed you must maintain in order to arrive in Cincinnati before 1:15 p.m.?

A. 35
B. 40
C. 45
D. 50
E. 55

Hint: use your formula sheet to determine the formula for calculating distance.
(d = r x t where d = distance; r = rate; t = time)

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
6. Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

Information Needed

Departure and arrival times
Mileage at the time of departure and arrival
Formula for rate

Skills Needed

Solving a simple equation
Sorting of information to determine what is necessary to solve a problem
Solving problems with more than one unknown

Solution Method

From Cleveland to Columbus

Time: 7:45 a.m. to 10:30 a.m. → 2 hours 45 minutes or 2.75 hours

Distance: 126 miles

From Columbus to Cincinnati

Time: 10:30 a.m. to 1:15 p.m.

10:30 a.m. to 12 noon, which equals 1 hr 30 min

+ 12 noon to 1:15 p.m., which equals 1 hr 15 min

1 hr 30 min + 1 hr 15 min = 2 hr 45 min, which is 2.75 hours

Distance: 235 total – 126 Cleveland to Columbus = 109 miles from Columbus to Cincinnati

$$d = r \times t$$

$$109 = r \times 2.75$$

$$\frac{109}{2.75} = r$$

$$39.63 = r$$

Round to 40 mph. With a needed rate of 39.6 mph, you should maintain ***at least* 40 mph**.

Answer

40

Notes:

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IMPROVING TO LEVEL 7

PROBLEM 7.5: Hot Air Balloon

LEARNER PAGE

You are planning to replace your hot air balloon. There are various sizes from which to choose. Which of the following shapes would offer the greatest volume of hot air when the balloon is inflated?

A. a cylinder with a radius of 80 ft and a height of 40 ft

B. a cube with a side length of 90 ft

C. a cylinder with a diameter of 100 ft and a height of 8 ft

D. a ball with a radius of 60 ft

E. a ball with a diameter of 110 ft

DRAWING SPACE:

NEEDED INFORMATION (Have you included the correct formula?):

SOLVE:

CHECK your work. Is your answer reasonable?

PROBLEM 7.5: Hot Air Balloon

INSTRUCTOR'S GUIDE

Problem

You are planning to replace your hot air balloon. There are various sizes from which to choose. Which of the following shapes would offer the greatest volume of hot air when the balloon is inflated?

A. a cylinder with a radius of 80 ft and a height of 40 ft
B. a cube with a side length of 90 ft
C. a cylinder with a diameter of 100 ft and a height of 80 ft
D. a ball with a radius of 60 ft
E. a ball with a diameter of 110 ft

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
10. Find the perimeters (circumferences) and areas of polygons (circles).
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic

2. Estimate answers, compute, and solve problems involving real numbers.

Information Needed

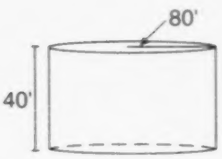
Dimensions of each shape
Volume formulas for each shape

Skills Needed

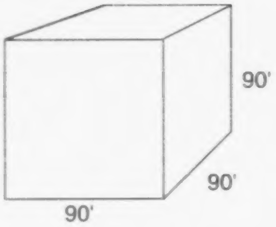
Calculating volumes of various solids

Solution Method

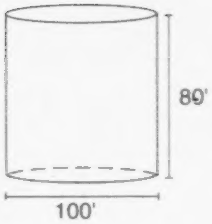
A.



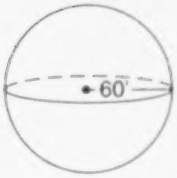
B.



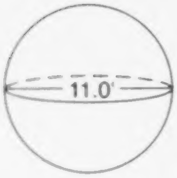
C.



D.



E.



A cylinder volume $= 3.14 \times (\text{radius})^2 \times \text{height}$

$= 3.14 \times (80\text{ ft})^2 \times 40\text{ ft}$

$= 3.14 \times 6400\text{ ft}^2 \times 40\text{ ft}$

$= 803{,}840\text{ ft}^3$

B cube volume $= (\text{side})^3$

$= (90\text{ ft})^3$

$= 729{,}000\text{ ft}^3$

C cylinder volume 100 ft diameter ÷ 2 = 50 ft radius

$= 3.14 \times (\text{radius})^2 \times \text{height}$

$= 3.14 \times (50\text{ ft})^2 \times 80\text{ ft}$

$= 3.14 \times 2500\text{ ft}^2 \times 80\text{ ft}$

$= 628{,}000\text{ ft}^3$

D ball $= \frac{4}{3} \times 3.14 \times (\text{radius})^3$

$= \frac{4}{3} \times 3.14 \times (60\text{ ft})^3$

$= \frac{4}{3} \times 3.14 \times 216{,}000\text{ ft}^3$

$= 904{,}319.96\text{ ft}^3$ or $904{,}320\text{ ft}^3$

E ball $= \frac{4}{3} \times 3.14 \times (\text{radius})^3$ 110 ft diameter ÷ 2 = 55 ft radius

$= \frac{4}{3} \times 3.14 \times (55\text{ ft})^3$

(Obviously smaller than D → stop the computation)

Answer

A ball with a radius of 60 ft

Notes:

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Problem 7.6: Wrapping for a Package **LEARNER PAGE**

Trevon is mailing a package to his brother in Columbus, Ohio. The box has the following dimensions: length = 57 in; width = 30 in; height = 42 in. Trevon must allow an additional 8% for overlapping. To the nearest square foot, how much paper will be needed?

A. 75 ft^2
B. 77 ft^2
C. 79 ft^2
D. 81 ft^2
E. 83 ft^2

DRAWING SPACE:

LIST NECESSARY INFORMATION:

SOLVE:

CHECK your work. Is your answer reasonable?

Problem 7.6: Wrapping for a Package INSTRUCTOR'S GUIDE

Problem

Trevon is mailing a package to his brother in Columbus, Ohio. The box has the following dimensions: length = 57 in; width = 30 in; height = 42 in. Trevon must allow an additional 8% for overlapping. To the nearest square foot, how much paper will be needed?

A. 75 ft^2
B. 77 ft^2
C. 79 ft^2
D. 81 ft^2
E. 83 ft^2

Ohio Mathematics Proficiency Outcomes

The 9th and 12th grade proficiency outcomes that are addressed in this practice problem are indicated below. All outcomes are described in Appendix D, pp. 339-344.

Ninth-Grade Proficiency Outcomes

1. Compute with whole numbers, fractions, and decimals.
5. Solve problems and make applications involving percentages.
11. Find surface areas and volumes of rectangular solids.
15. Solve simple number sentences and use formulas.

Twelfth-Grade Proficiency Outcomes

Strand I: Arithmetic
2. Estimate answers, compute, and solve problems involving real numbers.

Strand II: Measurement
3. Determine area and volume.

Strand IV: Algebra/Functions
8. Translate verbal statements into symbolic language.

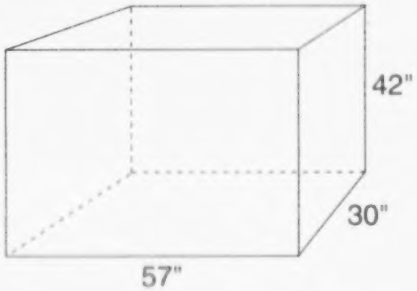
Information Needed

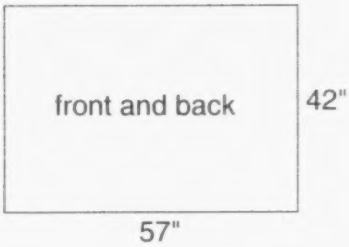
Surface area formulas (The formula for the area of a rectangle = length x width)
Conversion facts (144 in^2 = 1 ft^2)

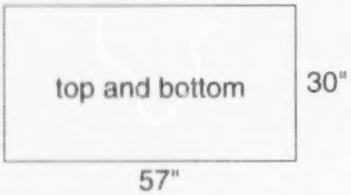
Skills Needed

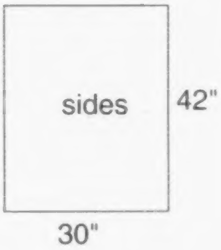
Determining surface areas
Finding basic percentage

Solution Method 1









Area		**Area**		**Area**		
Surface area	=	top and bottom	+	front and back	+	2 sides
	=	(30 in x 57 in) x 2	+	(57 in x 42 in) x 2	+	(42 in x 30 in) x 2
	=	(1710 in^2) x 2	+	(2394 in^2)	+	(1260 in^2) x 2
	=	3420 in^2	+	4788 in^2	+	2520 in^2
	=	10,728 in^2	÷	144 in^2/ft^2	=	74.5 ft^2
		8% overlap	=	.08 x 74.5 ft^2	=	5.96 ft^2
		74.5 ft^2	+	5.96 ft^2	=	80.46ft^2 rounded to 81 ft^2

Solution Method 2

$(57 \times 42) \times 2 = 4788 \text{ in}^2$
$(30 \times 42) \times 2 = 2520 \text{ in}^2$
$(30 \times 57) \times 2 = 3420 \text{ in}^2$

$4788 + 2520 + 3420 = 10{,}728 \text{ in}^2$

$$10{,}728 \text{ in}^2 \times 108\% = \frac{11{,}586 \text{ in}^2}{144 \text{ in}^2} = 80.46 \text{ ft}^2$$

Round to **81 ft^2**

Answer

81 ft^2

MATHEMATICS

TARGETS
FOR
LEARNING

BEST COPY AVAILABLE

Appendix A

References

Adkinson, S., M. Fleer, eds. (1995). *Science With Reason.* Portsmouth, NH: Heinemann Educational Books, Inc.

American Association for the Advancement of Science (1990). *Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology.* New York: Oxford University Press.

American College Testing Program (1995). *Targets for Instruction* (Applied Mathematics). Iowa City, IA: ACT.

National Council of Teachers of Mathematics (1993). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: NCTM.

National Research Council (1996). *National Science Educational Standards.* Washington, DC: National Academy Press.

Ohio Department of Education (1980). *Problem Solving: A Basic Mathematics Goal.* Columbus, OH: ODE.

The Secretary's Commission on Achieving Necessary Skills (1992). *Learning a Living: A Blueprint for High Performance: A SCANS Report for America 2000.* Washington, DC: U.S. Department of Labor.

Sadker, M., D. Sadker (1994). *Failing at Fairness: How America's Schools Cheat Girls.* New York: Charles Scribner's Sons.

Appendix B

Applied Math Resources

This appendix contains resources that will help teachers develop learning activities for learners. The resources are divided into the following categories:

- Textbooks That Include Supplemental Practice Problems
- Resources for Applied Math Instructors
- Instructional Computer Software and Laser Disks
- Suppliers of Math and Science Resources and Materials
- Internet Sites

It is important to note that some of the following resources were developed for learners who are younger than those you might be instructing. However, don't rule out using them because many can be easily and effectively adapted for use with older learners.

Applied Math Resources

Many of the books written for learners in vocational programs include applied math problems that would be appropriate for use by Work Keys instructors. However, the problems in standard vocational textbooks do not include **complex** problems. Instead, problems are broken down into primarily **single-step** problems. Instructors who are helping learners attain higher Work Keys levels will need to **make textbook problems resemble real-life situations by making them more complex and adding extraneous information**.

Textbooks That Include Supplemental Practice Problems

The following list of resources is not comprehensive, but it will help get you started. Other resources may be available from your library and your local vocational school. Additional titles recommended by pilot teachers include:

- *Applied Mathematics* (Goodhart-Wilcox),
- *Mathematics Applications and Connections* (Glenncoe McGraw-Hill), and
- *Mathematics Achievement Through Problem Solving* (MAPS).

Furthermore, publishers such as South-Western, Delmar, Goodhart-Wilcox, and Glencoe McGraw Hill distribute books about applied math, integrated math, and mathematical applications in a wide variety of vocational areas.

Agency for Instructional Technology (1997). *Mathmedia*. Bloomington, IN: AIT.
Mathmedia supplements pre-algebra curriculum by showing learners how mathematical principles are applied to 12 real-world situations. Developed for 7-12 grade learners, the AIT program includes six video tapes, three videodiscs, a student guide, and a teacher guide. Topics are graphs; decimals and exponents; logical reasoning; measurement; fractions; positive and negative numbers; formulas; ratios; percentages; area and volume; probability; and coordinates. Call 800/457-4509 for a free video information kit.

Center for Occupational Research and Development (1997). *CORD Applied Mathematics: A Contextual Approach to Integrated Algebra and Geometry*. Waco, TX: CORD.
CORD Applied Mathematics teaches algebra and geometry concepts in the context of occupational settings. Course materials engage learners in cooperative teams—allowing them to participate in laboratory-centered, hands-on activities that make math concepts practical and relevant. Activities emphasize problem solving, decision making, and hands-on learning. Materials are distributed by South-Western Educational Publishing, 800/453-7882.

Downie, D., J. Stenmark, and T. Slesnick (1981). *EQUALS: Math for Girls and Other Problem Solvers*. Berkeley, CA: Lawrence Hall of Science, University of California.

EQUALS includes suggestions of instructional strategies for instructors and many high-quality problems for learners to solve.

Gardella, F. et al. (1994). *Mathematical Connections: A Bridge to Algebra and Geometry.* Boston: Houghton Mifflin Company.

In addition to traditional, drill-style worksheets, this textbook includes instruction on problem solving, practice with problem solving, and workplace applications. Topics include integers; equations; graphs and data analysis; rational numbers; ratio, proportion, and percent; circles and polygons, statistics and circle graphs; probability; and surface area and volume. These problems would be most appropriate for learners improving to Work Keys Levels 3 and 4; they can be adapted to higher-level learners.

Goetsch, D., D. Goetsch, and R. Rickman (1996). *Applied Mathematics for Technology and Careers*. Englewood Cliffs, NJ: Prentice Hall.

This books provides worksheets and practice problems with application to a wide variety of occupations. Most appropriate for learners improving to Work Keys Levels 3-5, these problems are adaptable for higher-level learners.

Greenes, C. (1977). *Problem-Mathics: Mathematical Challenge Problems with Solutions Strategies*. Palo Alto, CA: Creative Publications.

Kaseberg, A., N. Kreinberg, D. Downie (1980). *Use EQUALS to Promote the Participation of Women in Mathematics*. Berkeley, CA: Lawrence Hall of Science, University of California.

This book contains many activities to help learners become more skilled mathematical problem solvers. In addition, it includes some activities that help girls and others become aware of careers that involve math.

Moore, G. (1992). *Practical Problems in Mathematics for Automotive Technicians*. Albany, NY: Delmar Publishers, Inc.

This book contains worksheets and practice problems on whole numbers, fractions, decimal fractions, ratios and proportions, measurement, percents, averages, formulas, graphs; and invoices. It also includes detailed instruction on using a basic calculator. Workplace problems represent those encountered by automotive technicians. These problems would be most appropriate for learners improving to Work Keys Levels 3 and 4; they can be adapted to higher-level learners.

Southam, J. and C. Nahrgang (1990). *Vocational Mathematics*. Cincinnati, OH: South-Western Publishing Co.

This book contains worksheets and practice problems on decimals; fractions; percents; weights and measures; estimation; keeping a checking account; calculating interest and time-payment plans; purchase orders and invoices; cash discounts; selling goods; calculating for payrolls; and inventory valuation. Most appropriate for learners improving to Work Keys Levels 3-4, these problems are adaptable for higher-level learners.

Sullivan, R. (1982). *Practical Problems in Mathematics for Electronics Technicians.* Albany, NY: Delmar Publishers, Inc.

This book contains worksheets and practice problems on whole numbers, fractions, decimal fractions; ratios and proportions; measurement and graphs; and percents, averages, and tolerances. Workplace problems represent those encountered by electronics technicians. Appropriate for learners at all Work Keys Levels.

Taylor, D. et al. (1991). *Applied Math for Facilities Maintenance: Instructor's Guide.* Waco: Texas State Technical College.

This guide accompanies a videodisc that trains custodial workers, grounds keepers, and plant operators. It includes a wide variety of work-based practice problems that teach and reinforce the skills of fractions and proportions; measurements and conversions; and shapes and dimensions. Most appropriate for learners improving to Work Keys Levels 3 and 4, these problems are adaptable for higher-level learners.

Resources for Applied Math Instructors

In addition to the following list of resources, instructors may wish to consult the *Mathematics Teacher Resource Handbook: A Practical Guide for K-12 Mathematics Curriculum* (1993) published by Kraus International Publications. It provides current information on publications, standards, and special materials for K-8 mathematics instruction.

Activities Integrating Mathematics and Science (AIMS). Fresno, CA: AIMS.
Electrical Connections
Finding Your Bearings
Machine Shop
Math + Science, A Solution

The AIMS books provide instructors with a wide variety of hands-on activities designed to be used in grades 4-9. In many of the activities, learners are required to solve practical, everyday problems. AIMS materials are available through retailers or directly from AIMS at 209/255-4094.

Adkinson, S., ed. (1992). *Mathematics With Reason: The Emergent Approach to Primary Maths.* Portsmouth, NH: Heinemann Educational Books, Inc.
This book explores how elementary (grades pre-K-7) mathematics teachers can make their teaching more effective both at home and at school. Topics of problem solving, standard notation, graphing, children's intuitive methods, teacher confidence and organization are addressed.

Alper, L. et al. (May 1996). "Problem-Based Mathematics: Not Just for the College Bound." *Educational Leadership*, 18-21.
This article describes the Interactive Mathematics Program (IMP) funded by the National Science Foundation. The four-year program replaces traditional courses with problem-based curriculum that emphasizes helping learners make connections between key mathematical ideas and their real-world applications.

Brumbaugh, D. and L. Brumbaugh (1988). *Scratch Your Brain Where It Itches.* Pacific Grove, CA: Critical Thinking Books & Software.
Developed for each grade level (1-12), this series provides exercises that promote mathematical reasoning and critical thinking. It includes games, tricks, and quick activities in math, algebra, and geometry.

Center for Mathematics, Science, and Technology Education (1995). *Manufacturing.* Normal, IL: Illinois State University.

CeMAST has developed six sequential modules that progressively increase the integration of math, science, and technology through the use of hands-on activities. Developed for grade 7, *Manufacturing* is the fifth module in the series and focuses on the importance of manufacturing to society. The activities involve making a book cover and learning the operations that lead to a marketable product. The curriculum, which follows the national science standards, can be ordered from CeMAST at 309/438-3089; fax 309/438-3592. A commercial edition may also be available at the time of this printing. Manufacturing is in the collection of the Eisenhower National Clearinghouse, which is described in the Suppliers of Science Resources and Materials section of this appendix.

Fixx, J. (1972, 1976). *Games for the Superintelligent* and *More Games for the Superintelligent.* Garden City, NY: Doubleday & Company, Inc.

These books include many math, logic, and word puzzles that can be used with 8th grade through adult learners.

Fraser, S. (1982). *SPACES: Solving Problems of Access to Careers in Engineering and Science.* Berkeley, CA: Lawrence Hall of Science, University of California.

This book provides learners with opportunities to solve many design-related problems.

Great Explorations in Math and Science (GEMS) guides were developed by the Lawrence Hall of Science at the University of California, Berkeley.

GEMS guides, which were developed to be used by non-science and non-math teachers, involve learners in hands-on, inquiry-based learning. Each guide comprises a comprehensive, ready-to-use unit on a given topic, which was designed for a range of grade levels. The following is a partial list of the books that are available from GEMS at this printing. Many other GEMS titles, including those pertaining to biology, ecology, physical science, and collaborative learning are also available; new titles are being developed every year. GEMS materials are available through many suppliers, including William Sheridan Associates, which is described in the Suppliers of Science Resources and Materials section of this appendix. GEMS staff can be reached directly at 510/642-7771; fax 510/643-0309.

Group Solutions and Group Solutions Too: Cooperative Logic Activities (grades K-5)
Height-O-Meters (grades 6-10)

Pedagogical handbooks:
GEMS Teacher's Handbook
GEMS Leader's Handbook
Insights and Outcomes: Assessment for GEMS Activities

Girls, Inc. (1990). *The Power Project: Operation SMART Activity Guide.* New York: Girls Inc.

This practical, easy-to-use guide presents a solid program to encourage girls in science, math, and technology. It enables non-science teachers to facilitate inquiry-based learning about power, simple machines, and the environment. Although developed for middle-school and high-school girls, it is a solid program for all learners including adults. It is available from the Girls, Inc. Resource Center at 317/634-7546.

Girls, Inc. (1990). *Spinnerets and Know-How: Operation SMART Planning Guide.* New York: Girls Inc.

Spinnerets lays the foundation for developing a program to encourage girls in science, math, and technology. A practical guide, it helps educators and others develop an effective, inquiry-based program for girls, particularly those in middle school and high school, or mixed-gender groups. Materials can be ordered from Girls, Inc. Resource Center at 317/634-7546.

Haradek, A. (1991). *Cranium Crackers.* Pacific Grove, CA: Critical Thinking Books & Software.

Formerly titled *Critical Thinking Activities for Mathematics,* this series was developed for each grade level (3-12). It presents problems that develop the critical thinking skills needed to succeed in math. Ideas are introduced clearly; simple examples are provided.

Heid, M. K. (1995). *Algebra in a Technological World.* Reston, VA: National Council of Teachers of Mathematics.

This book, intended for grades 9-12 classroom teachers, curriculum developers, and teacher educators, addresses the teaching and learning of high school algebra in light of the *NCTM Curriculum and Evaluation Standards for School Mathematics.* Model lessons with real-world applications are included.

Hill, W. and D. Edwards (1988). *Mathematical Reasoning Through Verbal Analysis.* Pacific Grove, CA: Critical Thinking Books & Software.

Developed for grades 2-4 and 4-8, this series presents class discussion activities that help learners develop the mathematical problem-solving skills recommended in the national math standards. Multiple strategies for solutions are provided for each activity.

Illingworth, M. (1996). *Real-Life Math Problem Solving.* New York, NY: Scholastic Professional Books.

This resource contains 40 classroom-tested problems and provides instructors with annotated solutions. Other books in the Scholastic Professional Books Series might also be of interest, including *Estimation Investigations, Thirty Wild and Wonderful Math Stories,* and *Mental Math: Computation Activities for Anytime.*

Isaccson, K. (1994). *Playing the Market.* White Plains, NY: Dale Seymour.

This step-by-step guide use the stock market as a way to teach math and apply mathematical principles to stock market-related activities. In group activities, learners practice constructing and reading graphs, converting fractions to decimals, multiplying decimals, finding percents, and practicing computation and calculator skills. Developed for grades 5-12.

Johnson, D. (1982 and 1985). *Every Minute Counts: Making Your Math Class Work and Making Minutes Count Even More.* White Plains, NY: Dale Seymour Publications.

In these books, practical, teacher-tested suggestions that can be implemented immediately on managing a math classroom are provided for middle- and high-school teachers.

Jorgensen, M. (1993) *Assessing Habits of the Mind: Performance-Based Assessment in Science and Math.* ERIC Math, Science, and Technology Clearinghouse.

The ERIC Clearinghouse is described in the Suppliers of Science Resources and Materials section of this appendix.

Kaseberg, A., N. Kreinberg, and D. Downie (1980). *Use EQUALS to Promote Participation of Women in Mathematics.* Berkeley, CA: Lawrence Hall of Science.

This book provides educators, parents, and youth group leaders with insights about gender equity in math. Many strategies are suggested. Ready-to-use activities and games are provided on topics that include creating workshops, encouraging career aspirations, improving problem-solving strategies, and equity in the classroom.

Lovitt, C. and D. Clarke (1992). *Mathematics Curriculum and Teaching Program.* Reston, VA: National Council of Teachers of Mathematics.

This K-10 math curriculum resource kit is a collaborative program with computer software, videos, and printed curriculum materials. Topics include probability, estimation, problem solving, geometry, logic, algebra, number properties, and visual imagery.

Real World Math Series (1991). *Real World Math: Classroom Math Projects.* Whittier, CA: Real-World Educational Products.

Real World Math provides instructors with math projects for use with the building game, the stock market game, and the real estate game.

Reichbart, C. and Reichbart (January-March 1995). "Professional Development: Promoting Problem-Solving Expertise." *Mathematics: Teaching in the Middle School.* 310-316.

This article illustrates general approaches to teaching non-routine problem solving. It compares expert and novice approaches. Sample problems and additional resources are provided.

Sadker, M., D. Sadker (1994). *Failing at Fairness: How America's Schools Cheat Girls.* New York: Charles Scribner's Sons.

This book describes ways in which males and females are given different treatment in school and makes concrete, easy-to-implement suggestions for instructors.

Silver, E. et al. (1990). *Thinking Through Mathematics: Fostering Inquiry and Communication in Mathematics Classrooms.* Forester Center, WV: College Board Publications.

This book proposes ways that instructors can use a problem-solving approach to connect thinking and math. It is part of the *Thinking Series,* which addresses teaching all students how to become competent thinkers.

Sports Math Series (1983). *BaseballMath, BasketballMath,* and *OlympicMath.* White Plains, NY: Dale Seymour.

These books, developed for learners in grades 4-8, provide practice in mathematical calculations and analysis within the context of sports.

St. Andre, R. (1997). *Simple Machines Made Simple.* White Plains, NY: Dale Seymour.

This book is full of hands-on projects to help teach the fundamentals of levers, pulleys, spring scales, gears, wheels, axles, and other simple machines.

Stacey, K. and S. Groves (1985). *Strategies for Problem Solving: Lesson Plans for Developing Mathematical Thinking.* White Plains, NY: Dale Seymour Publications.

This resource, which was developed for teachers of grades 7-10, teaches learners to solve non-routine mathematical problems. Lessons teach specified problem solving skills.

Stenmark, J., V. Thompson, R. Cossey (1986). *Family Math.* Berkeley, CA: Lawrence Hall of Science.

This resource provides educators, parents, and learners with a wide array of practical, hands-on activities to enhance math and problem-solving skills.

TOPS Learning Systems

The following resources provide learners with thoughtfully sequenced activities to teach and reinforce specific math and science principles as well as process skills through hands-on, guided discovery. Because TOPS is a nonprofit organization, its books are inexpensive ($8-16). Most activities require low-cost, everyday materials. TOPS materials can be purchased from many suppliers, including William Sheridan & Associates, listed in the Suppliers of Science Resources and Materials section of this appendix, or from TOPS at 10970 Mulino Road, Canby, OR 97013; 503/266-8550; fax 503/266-5200; e-mail tops@canby.com.

Open-Ended Task Card Series

Designed for 7-12 graders and adaptable for younger and older learners; each series includes 16-28 lessons and notes for teaching each lesson. Newly revised. The following series topics pertain to real-life problem solving:

Analysis
Graphing
Math Lab
Measuring
Metric Measuring
Weighing
Probability

Women's Educational Equity Act (WEEA) Equity Resource Center (1995). *Gender-Fair Math.* Newton, MA: WEEA.

This book provides suggestions for parents, teachers, administrators, and community program providers. Classroom tools and strategies for helping female learners increase their confidence and interest in math are included.

Instructional Computer Software and Laser Disks

There are many software packages on the market; many are not much more than a workbook of drills designed to reinforce basic skills. Educators and parents are encouraged to select software that encourages learners to develop **critical thinking and problem-solving skills**. The following software packages meet this criteria.

Center for Occupational Research and Development and Quicksilver Software, Inc. (1996). *Math at Work* CD-ROM Series.

These CD-ROMs show learners where math is used in the workplace and engages them in real-world problem solving. Activities correspond with *CORD Applied Mathematics* units. For additional information and a demo-CD, contact CORD at 800/231-3015.

Math At Work titles include:
Cybersnacks
Gearing Up
Pooling Around
Train Reactions

Edenmark Corporation, *Strategy Challenges*, Collections 1 and 2

This software package, which is appropriate for ages 9-18, encourages strategic planning and problem solving, although it does not target any specific discipline. By way of a wide variety of games and activities, learners use the problem-solving process to confront real-life situations that require critical thinking. This software was field tested and rated very highly by teachers participating in the Ohio SchoolNet Plus Software Review Project. The package is distributed by Edmark Corporation, P.O. Box 97012, Redmond, WA 98073; 800/362-2890; fax 206/556-8430; edmarkteam@edmark.com. It is in the collection of the Eisenhower National Clearinghouse, which is described in the Suppliers of Science Resources and Materials section of this appendix.

The Learning Company, Inc.

The following software packages were developed by the award-winning Learning Company. Each helps learners build their understanding of basic mathematical principles. In addition, each package gives learners many opportunities to do hands-on experimentation, deductive reasoning, and real-world problem solving. The age range for each software package appears below. The author believes that learners of any age will enjoy using these materials. Refer to the Suppliers of Math and Science Resources and Materials section of this appendix for ordering information.

The Learning Company's Software for Integrated Math and Science Problem Solving:

The Geometric Golfer	Teaches transformational geometry; encourages development of spatial and visualization skills. (Ages 12-18)
MacStat!	Learners enter data into spreadsheets and then analyze the data. (Ages 12-18)
Math Keys: Unlocking Fractions and Decimals	Teaches fractions, including the relationship between fractions and decimal quantities. (Ages 8-12)
Number Munchers	Learners practice basic mathematical skills. (Ages 8 to 18)
Operation Neptune	Provides an introduction and applications of algebraic equations using whole numbers, fractions, decimals, ratios, and percentages. (Ages 10-16)
Probability Lab	Teaches probability through computer-simulated experiments. (Ages 12-18)
Super Solvers OutNumbered!	Learners solve mysteries using deduction and logic. (Ages 8-10)
TesselMania	Learners build complex geometric shapes using tessellations, which are the interlocking images found in M.C. Escher's art. (Ages 8-18)
TesselMania DELUXE	This is an enhanced version of TesselMania. (Ages 8-18)

The Learning Company's Software for Thinking and Problem Solving:

Logic Quest	Learners use strategic thinking and problem solving to solve mazes, puzzles, and 3-dimensional construction activities. (Ages 9-16)
The Secret Island of Dr. Quandary	Learners must solve puzzles through logic and prediction. (Ages 8-18)
Super Solvers Gizmos & Gadgets!	Learners solve problems involving puzzles and simple machines. (Ages 8-12)

Suppliers of Math and Science Resources and Materials

Agency for Instructional Technology (AIT)

AIT is a consortium that develops and distributes instructional materials for the arts, science, mathematics, language arts, social studies, professional development, and school-to-work. AIT can be reached at 800/457-4509.

Center for Occupational Research and Development (CORD)

CORD develops and distributes applied math and applied science materials, as described in the Resources for Teachers and Trainers of Applied Technology section of this appendix. CORD can be reached at P.O. Box 21206, Waco, TX 76702-1206; 800/231-3015.

ERIC Clearinghouse for Science, Mathematics, and Environmental Education

The ERIC clearinghouse maintains a comprehensive database on science, mathematics, and environmental education. ERIC also publishes brief summaries of research findings and practices related to science, math, and technology education. It is located at 1929 Kenny Road, Columbus, Ohio 43210-1080; 800/538-3742.

Eisenhower National Clearinghouse for Mathematics and Science Education (ENC)

The ENC was established to help K-12 teachers locate and examine useful teaching materials. The clearinghouse maintains many types of materials (e.g., books, software programs, videodiscs, kits) at its repository at The Ohio State University in Columbus. Teachers can make an on-site examination of these materials. ENC also publishes reviews of instructional materials, which can be accessed on line. In addition, ENC's reference librarians provide individualized consultations. Their reference desk can be reached at 1929 Kenny Road, Columbus, OH 43210-1079; 800/621-5785 or 614/292-7784; fax 614/292-2066; e-mail info@enc.org.

Great Explorations in Math and Science (GEMS)

GEMS develops materials and provides in-service training to educators on topics concerning inquiry-based science and math. This organization does much of their work through regional support centers, which are also network sites. The GEMS materials noted on the resource list can be obtained from William Sheridan & Associates (listed in this section of the appendix) or directly from GEMS. GEMS staff members can be reached at the Lawrence Hall of Science, University of California, Berkeley, CA 94720-5200; 510/642-7771; fax 510/643-0309.

Technological Studies at the College of New Jersey

The College of New Jersey provides several resources for teachers of technology, as follows:

- The magazine, *ties*, supports technology education and the integration of math, science, and technology in middle school through high school. Published six times a year, *ties* is free to educators.
- Technology instructors can learn more about teaching design, problem solving, and technology by watching any of 70 videos that address topics such as design; drawing and modeling; materials and process; control and electronics; machines and mechanisms; and the teaching of design and technology.

Subscribe to *ties* magazine or order videos by contacting the College of New Jersey at 103 Armstrong Hall, Hillwood Lakes, CN 4700, Trenton, NJ 08650-4700; 609/771-3333; fax 609/771-3330; e-mail ties@tcnj.edu.

The Learning Company

Distributors of educational software, The Learning Company has two divisions. The school division can be reached at 800/685-6322. They offer 30-day previews as well as regional preview centers. Product information is available from their web site, which is http://www.learningco.com/. Their non-educator software can be purchased from retailers or directly from The Learning Company at One Anthenaeum Street, Cambridge, MA 02142; 800/227-5609.

Women's Educational Equity Act (WEEA) Program's Publishing Center

WEEA distributes a wide variety of materials about topics related to educational equity, including disabilities, gender equity, careers, history, math, science, and technology. A catalog and/or materials can be obtained from WEEA at 55 Chapel Street, Suite 224, Newton, MA 02158-1060; 800/793-5076; e-mail WEEApub@EDC.org. This organization's Internet address is http://www.edc.org/CEEC/WEEA.

William Sheridan & Associates

William Sheridan & Associates carries a wide variety of math and science materials. The company also offers a plethora of written resources including many of those listed on the previous pages. Bill Sheridan and his staff provides friendly, personal service and can obtain nearly anything you need. Sheridan has several catalogs of its own and also supplies the materials found in several other large national catalogs, including Delta Educational and Cuisenaire-Dale Seymour. If you're in the area, visit Sheridan's Discovery Store, with an adjacent training classroom, just north of Columbus, Ohio at 8311 Green Meadows Drive N., Lewis Center, OH 43035; 800/433-6259 or 614/548-0575; fax 614/548-0485.

Internet Sites*

American Mathematical Society	http://e-math.ams.org/
Appetizers and Lessons for Math and Reason	http://www.cam.org/-aselby/lesson.html
Ask ERIC Lesson Plans	gopher://ericir.syr.edu:70/11/Lessons/Math
Busy Teacher's Web Site K-12: Mathematics	http://www.ceismc.gatech.edu/BusyT/math.html
Clearinghouse for Mathematics and Science Education	http://www.nsta.org
Council on Basic Education (Smithsonian Institution's Science Lesson Plans)	www.c-b-c.org
Directory of Mathematics Resources	http://galaxy.tradewave.com/galaxy/Science/Mathematics.html
Eisenhower National Clearinghouse for Mathematics and Science Education	http://www.enc.org
ERIC Clearinghouse for Science, Mathematics, and Environmental Education	http://www.ericse.org
The Geometry Center	http://www.geom.un/mn.edu/welcome.html
Improving Math & Science Education	http://www.learner.org/content/k12
Lawrence Hall of Science	http://www.lhs.berkeley.edu/
Mathematics Archives (includes software)	http://archives.math.urk.edu/
MathWorld Interactive	http://www.mathworld-interactive.com
The Math Forum	http://forum.swarthmore.edu/
Math Source	http://mathsource.wri.com/
Math Teacher Link	http://www-cm.math.uiuc.edu/MathLink/

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*These Internet sites were accurate at the time of printing. However, they may change over time.

A Math Website for Middle School Students	http://www.umd.umich.edu/ jobrown/ math.html
McGraw-Hill Publishers	http://www.mcgraw-hill.com
National Council for Teachers of Mathematics	http://www.nctm.org
Newton's Apple Educational Materials	http://ericir.syr.edu/Newton/welcome.html
Science Education Resources	http://www.edu/intec/science.html
SchoolNet: Math Department	http://www.schoolnet.ca/math_sci/math/
Schools of California Online Resource for Educators: Mathematics	http://www.kings.k12.ca.us/math/
U.S. Department of Energy	http://www/doe/gov
U.S. Olympic PBS Cyber School	http://www.ibm.pbscyberschool.org

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*These Internet sites were accurate at the time of printing. However, they may change over time.

Appendix C

Problem-Based Learning Activities

The following problem-based learning (PBL) activities were developed by a team of high school math teachers. They provide learners with opportunities to solve challenging, real-world problems.

NOTE: The problems are not ordered by topic or by level of difficulty. To choose the problems that would be most beneficial to a specific group of learners, it is recommended that instructors read through all of the problems in this appendix, selecting those covering the mathematical principles needing to be addressed or reinforced for learners. Then, instructors should modify the problems to make them more simple or more complex as necessary to meet the needs of learners' Work Keys levels.

In addition, instructors may wish to present the problems in a way that simulates the workplace. For example, assign a monetary value to each project—based on its complexity. Time limits for completing each problem may also be specified. Furthermore, an assessment rubric is provided on p. 329. You may wish to use it when to grade learners' work. Some or all of the following ground rules may be used:

- You will work in four-member teams; your team will be your company. Your company is part of a large corporation, which is composed of your entire class.
- Select an original name for your company.
- The main goal of this project is to make money for your employer—the corporation. You can best accomplish this by producing high-quality work in an efficient amount of time. (The total amount of money earned by the corporation for the job equals the total paid for the job less salaries, fees, and penalties.)
- The corporation pays each team member $50/day.
- Each job will have a deadline. Failure to meet a deadline will cost your team a penalty of $100/day.
- When your team has a solution for a problem, you must present it in a neat, orderly report. You may also be asked to submit all of your preliminary work. (The corporation will specify whether your report will be written and/or verbal.)
- If your company's solution is returned for any reason, a $50 penalty will be charged to the team. So make sure all your ideas and proposals are complete before you turn them in.
- The Applied Math Project Rubric will be used for evaluation. An evaluation of "unacceptable" or "marginal" or in any three areas or any combination of four evaluations of "unacceptable," "marginal," and "acceptable" will result in a rejection of the project and a fine of $100 per day until the project is brought up to standard.

- You will be evaluated (graded) on the following factors, which reflect ways in which employees' effectiveness is judged in the workplace:
  - ✔ The amount of money your team makes for the corporation.
  - ✔ The teamwork and creativity that you show.
  - ✔ Your ability to stay on task and focused.
- If team members are absent, they will still be paid for the day. However, they must submit work on the problem for the time they have missed. In addition, you must decide as a team how many absent days will be allowed before a team member is penalized for missing too much work.
- These problems are not solely math problems—they are problems. Like real-world problems, they encompass several fields of study. Therefore, solving them will require your mathematical abilities as well as your creativity and common sense.

Applied Math Project Rubric

Difficulty	Unacceptable	Marginal	Acceptable	Exemplary
Depth of Thought	Major gaps are evident. Little or no reasoning is demonstrated.	There are major gaps in reasoning. Reasoning is somewhat apparent, but is flawed.	Reasoning is apparent, but a few minor gaps or flaws exist.	Reasoning is clear, concise, and effectively demonstrated.
Presentation	Written or oral presentation is characterized by haphazard, sloppy, or missing information. Written report is not typed.	The presentation lacks major points of emphasis and/or information is not provided in a professional manner.	The presentation is pleasant, pleasing, and informative and is clearly designed around informing the intended audience.	The presentation mimics professional quality. The message is clearly articulated to the intended audience.
Feasibility	The project solution is clearly not possible within the parameters set forth by the problem.	The feasibility was in question until an explanation was requested and given. The solution may not be possible within the parameters of the problem.	While the solution is valid, it may not be easily replicated.	It is clear that the method of solution is valid and can be easily replicated.
Attention to Detail	The project is generally characterized by superfluous or surface knowledge.	Only a few questions are answered in detail. The work generally does not attend to the underlying detail required by the problem.	Most of the questions posed by the problem are directly answered in detail.	Questions are anticipated and addressed. All measures, scales, and other required annotations are documented.
Creativity	The approach to the project is a direct replication of a previous design.	No new ideas are demonstrated. The approach is obviously related to a previous design, but some novelty is shown.	While the design presented may be similar in approach to others, their unique characteristics exist that make this design stand out.	The approach to the design is fresh, novel, and unique.

Problem: Concrete Project

You have been asked by a customer to respond to several questions concerning the pouring of a concrete driveway and sidewalk. The drive will be 10-feet wide and 45-feet long. Its depth will gradually range from six inches at the house to nine inches at the street. The depth will increase along the driveway at a constant rate. You should prepare appropriate scale drawings and price quotes for your presentation to the customer. Use the following steps to solve this problem:

- Calculate the number of cubic yards of concrete that should be ordered.
- The driveway is to slope at 40" away from the house for proper water runoff and water drainage. Determine the amount of drop off (i.e., difference in height) from the house to the end of the driveway.
- A sidewalk that is 30 inches wide and 22 feet long will be poured perpendicular to the driveway. It will be 5 inches in depth. Determine how many cubic yards of concrete should be ordered for the walk.

Problem: Deck Design

Archadeck Inc. has contracted with your company to design a prototype deck, which can be mass-produced at their manufacturing facility and assembled on site. The deck should be shaped like a regular hexagon. You have been asked to make a presentation to the client regarding how your company plans to fulfill Archadeck's contract. You will need to include the following:

- A scale drawing or blueprint containing specifications of the deck
- A comprehensive materials list, including how the pieces will be identified for final assembly at the site of final installation
- A description of the process that will be used at the site of final installation for assembly

Archadeck will pay a bonus if the proposal includes a three-dimensional scale model.

Problem: Yard Sign Template Design

The Parents All-Sports Booster Club has enlisted your expertise to develop a template for producing volleyball yard signs. The club members will sell the signs for their annual fund raising project. The template, which will allow the volleyball design to be added to a plain orange circle, will help the their boosters to produce their signs quickly and accurately.

The circular region will be made from ½″ plywood and is 30″ in diameter. Your task is to create a template that the boosters can draw around (or through) in order to create the design shown below. Your model template should include specific directions on how to use the template, and a felt-tip marker to create the design.

Problem: Cookie Design

A local cookie manufacturer has hired your company to determine if the placement of chocolate chips in their chocolate chip cookies have the random placement of chips needed to please their customers. You must create a three-dimensional graph that illustrates the location and size of the chocolate chips in five randomly selected cookies. Your presentation to the client must include appropriate graphic scale drawings of the "layers" of each cookie. It is suggested that you use a toothpick and an extra-small paint brush for your analysis.

Problem: Housing Development

A local contractor has asked you to submit a detailed proposal for installing sidewalks in a housing development that she is planning. The residents want sidewalks that allow a person to walk from one house to any other house in the development. To keep costs down, the contractor wants to build as few sidewalks as possible. There will be 34 houses in the development. Your task is to develop and present a design of the optimal layout for the houses and sidewalks. You should keep in mind that it is considered poor design to situate a house at the terminal (i.e., central) point of a trail—a minimum number of houses (hopefully none) should be situated at terminal locations.

Problem: Solar Cells

Many of the satellites that we put into orbit are powered by solar cells. These cells come in various shapes so they can cover most of the surface area of satellites. About 0.01 watt of electrical power is produced for each square centimeter of solar cell situated in direct sunlight. A solar cell in the shape of a regular hexagon delivers 15 watts. Find the minimum length of a side. Find also the dimensions of a circular cell that delivers 5 watts, and an equilateral triangle that delivers 10 watts. Be sure to provide an explanation, and calculate a margin of error for your findings.

Problem: Hotel Room Numbers

ABC Inn has adopted a new design for their hotels. Each will have a semicircular main lobby with hallways departing from it. Each hall will have the same number of rooms (up to ten) on each side of the hall, and there may be up to nine floors.

Your task is to develop a consistent room numbering system for the entire ABC chain. It should allow business travelers to "learn the system" and therefore be able to immediately identify the location of their rooms.

The prototype hotel is being built at Lake Buena Vista, Florida and will have nine floors and ten rooms in each spoke. You are to suggest at least three methods of numbering the rooms. You must describe the system as well as the rationale for why it would be easy for travelers to remember your proposed system.

Problem: Packaging

Since your packaging design company is relatively new, it is necessary for you to solicit some business. Your marketing plan is to suggest packaging improvements to manufacturers. You must choose a package that already exists and is packaged in some way. You should take that package and propose a *better* package for the product, then sell your "better package" to the manufacturer that currently uses the old packaging.

You should consider several criteria when designing this package, including the following:

- Creativity: The company wants to market this product, so it must be appealing to the eye.
- Cost of the materials: The company must produce thousands of these packages; therefore, the cost of each package is an important factor.
- Environmental issues: Does the new package use fewer materials than the previous package? What percent of the package can be recycled vs the old?
- Other purposes of packaging: Depending on the product contained the package you have chosen to target, you may need to consider additional factors (e.g., protection, keeping the item fresh).

Your report should completely explain the details of the package. Include information concerning the surface area, the total volume and the residual volume of both the old and new packages. You should also present a comparison of materials savings between the old and new packages. In addition, a scale drawing containing labels for all the necessary information should be prepared. A prototype model of your package would be a bonus.

Problem: Baseball Packaging

You have been hired to design a container that will hold six standard-sized baseballs. Your client, a sporting goods manufacturer, wants the package to minimize the use of cardboard (for both environmental and cost reasons). However, the client also wants the packages to stack efficiently on a shelf and be visually appealing. Your final report should include details such as:

- The amount of cardboard used per container
- The volume of the container
- The residual volume of the container when full (e.g., percentage of volume used)
- Technical drawings and/or prototype container

In addition, the manufacturer would like you to develop a plan for packaging these containers in a bigger box for shipping, with approximately 15 to 25 containers to fit each shipping box.

Problem: Swimming Pool and Courtyard Design

You have been hired by a hotel chain in Florida to design a swimming pool that will be a part of the outdoor courtyard. The customer wants the 2500-square yard courtyard to be a main attraction and focal point of the hotel. You have been given the following parameters:

- Because research indicates that refreshment sales are high at pool side, the courtyard should accommodate the maximum number of guests possible—without sacrificing aesthetic beauty.
- The pool should include a diving area, and allow guests to swim laps.
- The pool design should allow at least 10 guests to swim at the same time.
- Seating areas should be provided for both regular chairs and lounge chairs

Compile information for a formal presentation to the customer, including all specifications (e.g., lengths, angles, and areas) and a rationale for the each aspect of your design. Your presentation should help the customer to visualize every element of your proposed design.

Problem: Parking Lot Design

A local blacktop and resurfacing company plans to create a new parking lot for a shopping mall. They have hired you to study the feasibility of different types of parking spaces (e.g., perpendicular or angled) for the new lot. Your supervisor has asked you to conduct a random sampling of lots in the area to determine the following:

- Is there a standard angle, width, or length for a single painted space?
- Which type of lot most effectively uses the area (i.e., allows more cars)? Is there a standard ratio for comparison?
- If you find any standards, can you identify a rationale for them?
- Why might a store choose one option over the other, while another chooses the second over the first?

Using your findings and the size of the area to be developed, create a model for the mall lot. Include a mock up of your proposed line scheme, the volume (in cubic yards) of blacktop required (assume 12 inch thick), and the number of new spaces created. Remember to allow for the tree line setback along the perimeter of the lot. A detailed scale drawing is required by the customer.

To answer these questions, you will need to record the length, width, and angle measures for a single painted space in the sample lots. Be sure to answer any questions that you feel might be relevant (e.g., area of a single space, area of the entire lot). Does there appear to be a lot size where one type is more conducive than the other?

Problem: Grass Seed Mixtures

The Growth Center lawn service has asked you to supply charts which list the prices their employees should charge for bulk grass seed. The seed will be sold in 5 lb, 12 lb, 25 lb bags and in bulk lots of over 25 lb. Each mixture will be a combination of two types of seed: an all-purpose seed will be mixed with a shade seed or a sun seed. Prices are listed below. Provide data on mixture amounts and prices for each of the following:

Economy Sun Mixture	30% sun,70% all purpose
Economy Shade Mixture	30% shade, 70% all purpose
Standard Sun Mixture	60% sun, 40% all purpose
Standard Shade Mixture	60% shade, 40% all purpose
Deluxe Sun Mixture	80% sun, 20% all purpose
Deluxe Shade Mixture	80% shade, 20% all purpose

The final mark-up on these items should be 30% over the wholesale cost of the mixture. Growth Center pays $24 per 50-lb bag for all-purpose seed, $44 per 50-lb bag for sun seed, and $32 per 50-lb bag for their shade variety of seed.

Growth Center will reduce the price of the 10-lb bag 5% under the cost of two 5-lb bags, and will reduce the price of the 25-lb bag by 7% under the cost of five 5-lb bags. Bulk orders over 25 lb will receive a standard 9% discount.

Problem: Goldwin's Pendulum

The Goldwin Clock Company is considering the idea of putting the world's largest pendulum in their corporate offices in Chicago. Tim Goldwin, the company owner, wants your input regarding the size of this device and the amount of space required for installation and operation. You will need to determine the length and size of cable, the amount of weight needed at the end of the pendulum, the distance of arc, and the area of the floor space required. Prepare a complete report that includes one or more diagrams.

Problem: Deck Packages

Decks Unlimited is a manufacturer of recreational decking products. The company is undertaking an effort to standardize its home deck packages. They want to create a hexagonal deck of a given diameter that can be manufactured at their facility, shipped to the building site in modules, and assembled at the field site with a minimum of time.

The design of the deck modules has been left to another company. Your firm has been asked to calculate the least expensive way to purchase lumber for the decking floor boards. These boards are 5.25″ wide and are available in lengths of 6′ to 16′ in increasing increments of 2′. Your task is to find the combinations of lengths which can be cut to fit the deck at the lowest possible cost, and to write the deck boards section of the decking materials list. Current deck board costs are:

6′	$ 4.69
8′	$ 5.29
10′	$ 5.99
12′	$ 7.09
14′	$ 7.79
16′	$10.79

Problem: Tennis Ball Packaging

Your company has contracted with Elastipro to construct a packaging design for their new line of tennis balls. Their market research people have informed them that they should increase the number of balls in a container to four because the third ball in the present can containers is rarely used with the other two. For this reason, Elastipro has asked you to recommend a package that is:

- *Stackable* in order to use a minimum amount of retail shelf space.
- *Aesthetically pleasing* so that it will catch the eye of the consumer.
- *Functional*, so that it can serve as more than "just a can."

You should prepare a prototype of the container and a report that includes the following information:

- Surface area of the packaging material used
- Residual volume (wasted space) inside the package
- An explanation of how the product will be stacked for retail sale
- An explanation of how the container can be used

Problem: Guy Wire System

Your company has won a contract with Republic Flag Corporation to develop a guy wire system for their line of flag poles. These poles telescope to their eventual height, but Republic has been plagued with no method of insuring that each pole (which must be set in concrete for stability) is plumb.

Your company's Research and Development Department has created a novel method of attaching guy wires to each pole while the concrete sets, and allow the wire to be removed afterward. You need to do the following:

- Determine the length of the guy wires to be included in the package with each pole
- Establish a method of locating the wires at the exact angle and the exact distance from the base of the pole, which will guarantee a precisely plumb pole.

Problem: Residential Landscaping

A rustic log cabin, situated on a 3-acre parcel, is set in the center of 35 acres of field and forest. This parcel has been largely deforested, with only twelve of the original 60-foot hardwood trees remaining to the north of the cabin. A border of six-year-old Scotch pines grows on the western edge of the property. The driveway follows the line of pines. Little landscaping has been done, for the traditional flower beds that border the cabin's perimeter.

You have been asked by the owners to submit a bid for enhancing the 3-acre parcel. They want the additional landscaping to minimize grass mowing and trimming on the treed side of the drive. They would like this area to provide a place of entertainment and relaxation, possibly including a patio, trellis, or seating arrangement. In addition, they want both raised and ground-level plant beds. Your landscaping plan should blend with the natural atmosphere described in the first paragraph, while adding interest and a focal point.

Your customer expects a scaled drawing that includes the calculated areas of all beds, walkways, etc. The volumes of needed topsoil, mulch (assume 1″ thick), drainage materials, and/or other materials should be listed for ordering purposes. (Topsoil and mulch is usually purchased in cubic feet). Specific plant varieties and pricing would increase customer satisfaction!

Problem: Stair Stringers

Straiter's Carpentry, Inc. has asked you to create templates for their biggest carpentry nightmare—stair stringers. Stair stringers are the boards that support steps. They are cut out of 2″ x 12″ boards. If one wrong cut is made, the whole board is ruined. Design four templates for stringers according to the following parameters:

- A vertical step-up (rise) should be no more than 9″.
- The horizontal and vertical components should total 17″.
- Templates should be created for stairways with total heights of 3′, 4′, 6′, and 8′.

Prepare a report that includes scale drawings and/or templates that demonstrate each cut to be made, how long the cuts should be, and the total length of each stringer.

Problem: Dimitri's Department Store Mid-Year Sales

Dimitri's has hired you to prepare a mid-year sales report for their Board of Directors. Organize their sales information and develop a coherent report. The necessary data is supplied below. Your report should present the final inventory, monthly sales, monthly revenue, cumulative sales, cumulative revenue, and total revenue for each item. The specific items to be tracked in this report are jeans, shorts, shirts, socks, and jackets, and are listed in that order below.

Month	Units Received	Units Sold
January	720, 360, 600, 240, 360	499, 146, 384, 121, 247
February	660, 240, 540, 180, 240	642, 257, 479, 98, 214
March	660, 240, 600, 180, 120	751, 252, 783, 157, 258
April	720, 360, 660, 240, 60	707, 295, 491, 123, 44
May	660, 360, 660, 180, 40	513, 383, 712, 414, 13
June	720, 360, 330, 240, 0	609, 417, 232, 279, 7

Wholesale prices are as follows:

Jeans	$12.59	Shorts	$10.55	Shirts	$11.44	Socks	$.78	Jackets	$22.45

Initial Markup is 70%.

Discounts off of full retail prices for the store's monthly marketing initiatives were:

January	15%	April	25%
February	20%	May	20%
March	20%	June	30%

Problem: Miniature Golf Course

A campground is planning to install a miniature golf course near its recreation center. They would like to see your company's ideas for three different miniature golf holes before they make a final contract for the job.

They would like to see three uniquely different holes. They ask that one be a long hole, one be a short hole, and the third be a moderate-length hole. In your report, you should include the following information about each hole:

- The different slopes and elevations in the fairway between the tee and the hole
- The amount of wood needed to border the entire outside edge of the hole
- The amount of turf needed to cover the entire surface of the hole
- A scale drawing containing labels on all necessary measurements and showing any slope and elevation changes
- An explanation of the rationale behind each hole's design
- The estimated cost to build each hole

In addition, the client would like the design of each hole to allow for a hole-in-one. Using valid mathematical reasons, explain how a hole-in-one can be made, and show the path the ball would follow.

Appendix D

Ohio Mathematics Proficiency Outcomes

This appendix contains lists of Ohio Mathematics Proficiency Outcomes for grades nine and twelve. More complete information about proficiency outcomes and proficiency tests is provided in a variety of Ohio Department of Education publications. To learn more about the Ohio Proficiency Testing System or to order related publications, contact the ODE Assessment Center at 65 S. Front Street, Room 207, Columbus, Ohio 43215-4183; 614/466-0223.

Ohio Ninth-Grade Mathematics Proficiency Outcomes

The following outcomes, which are used by Ohio educators, were developed directly from the national mathematics standards.

1. *Compute with whole numbers, fractions, and decimals.* Problems require adding, subtracting, multiplying, and/or dividing whole numbers (with no more than four digits); fractions (each with denominators of 25 or less); and decimals (through thousandths).
2. *Compare, order, and determine equivalence of fractions, decimals, percents, whole numbers, and integers.* The symbols =, <, and > should be understood when involving comparisons using number line applications. Fractions, decimals, and percents may be encountered in the same problem.
3. *Solve and use proportions.*
4. *Round numbers to the nearest thousand, hundred, ten, one, tenth, and hundredth.*
5. *Solve problems and make applications involving percentages.*
6. *Select and compute with appropriate standard or metric units to measure length, area, volume, angles, weight, capacity, time, temperature, and money.*
7. *Convert, compare, and compute with common units of measurement within the same measurement system.*
8. *Read the scale on a measurement device to the nearest mark and make interpolations where appropriate.*
9. *Recognize, classify, and use characteristics of lines and simple two-dimensional figures.* Learners need to be familiar with concepts such as perpendicular, vertical, and parallel and be knowledgeable about triangles, quadrilaterals, pentagons, and circles.
10. *Find the perimeters (circumferences) and areas of polygons (circles).* Learners need to be familiar with and be able to apply the formulas for calculating the areas of triangles, rectangles, and circles. They also need to know an approximate value for π.
11. *Find surface areas and volumes of rectangular solids.*
12. *Read, interpret, and use tables, charts, maps, and graphs to identify patterns, note trends, and draw conclusions.*
13. *Use elementary notions of probability.*
14. *Compute averages.*
15. *Solve simple number sentences and use formulas.*
16. *Evaluate algebraic expression (simple substitutions).* Learners evaluate algebraic expressions that contain as many as three variables by using simple substitutions.

Ohio Twelfth-Grade Mathematics Proficiency Outcomes

The following outcomes, which are used by Ohio educators, were developed directly from the national mathematics standards.

Strand I: Arithmetic

1. *Compare, order, and determine equivalence of real numbers.* Such concepts include the relationship among integers, decimals, fractions, percents, and irrational numbers.
2. *Estimate answers, compute, and solve problems involving real numbers.* These concepts include basic arithmetic operations and estimation using integers, decimals, fractions, percents, and/or irrational numbers.

Strand II: Measurement

3. *Determine area and volume.* Learning includes the concepts of area and volume, and the ability to find the areas and volumes of simple geometric shapes or combinations of simple geometric shapes. Learners should understand the relationships among length, area, and volume. they should also be familiar with and be able to apply the formulas for areas of rectangles, circles, and triangles.
4. *Estimate and use measurements.* Common measurement units of time, length, area, weight, velocity and the like are included as well as the ability to choose the appropriate unit.

Strand III: Data Analysis

5. *Organize data into tables, charts, and graphs.*
6. *Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions.* This item could include decoding symbols according to a given key or making estimations.
7. *Determine probabilities of events involving unbiased objects.*

Strand IV: Algebra/Functions

8. *Translate verbal statements into symbolic language.* For example, set up an appropriate algebraic expression or equation from an English description of a situation.
9. *Simplify algebraic expressions.*
10. *Set up and solve linear equations.*
11. *Solve quadratic equations.*
12. *Solve systems of linear equations with two variables.*
13. *Graph linear functions.*
14. *Use the laws of exponents (including scientific notation).*

15. *Apply the Pythagorean theorem.* The theorem states that for any right triangle, $a^2 + b^2 = c^2$, where a and b are lengths of the leg (the two shorter sides) and c is the length of the hypotenuse (the longest side).
16. *Use deductive reasoning.* Such skills include drawing logical conclusions from given facts in situations involving spatial, geometric, or subset relationships.
17. *Describe and apply the properties of similar and congruent figures.* Such concepts include the relationships between angle measures and side lengths in similar and congruent figures, especially triangles.
18. *Determine slope, midpoint, and distance.*
19. *Demonstrate an understanding of angles and parallel and perpendicular lines.* The focus is on plane geometry.

Appendix E

Applied Math Tests

Appendix E offers specific applied math assessment tools. Each item is described below.

Applied Math Test Instructions

This sheet provides learners with instructions and helpful hints for taking the applied math tests. It should be given to learners who are taking the applied math tests provided in this section.

Mathematical Symbol and Formula Sheet

This sheet contains the same information provided on the Work Keys applied math test. It should be provided to learners who are taking the applied math tests that are provided in this section.

Learner's Response Sheet for Applied Math Tests

This sheet should be used by learners to record their answers to the applied math tests. It should be given to learners who are taking the applied math tests provided in this section.

Instructor's Answers to Applied Math Tests

This sheet provides instructors with the answers to both applied math tests (Test A and Test B).

Applied Math Test A

Test A can be used as a pretest, a post-test, or a practice test.

Applied Math Test B

Test B can be used as a pretest, a post-test, or a practice test.

Learner's Test Score Summary Sheet

This chart was designed for learners. Once tests are scored, learners mark a "✔" in the appropriate box for each correct response. They mark an "X" in the appropriate box for each incorrect response. Then they determine their Work Keys level by tallying their incorrect responses; if two or more problems are missed at a level, their learning intervention should begin at the next *lower* level.

Applied Math Summary Sheet

Instructors can use this sheet to summarize the applied math test scores of learners in their class. It can also be used to record learners' progress as they participate in learning activities and do practice problems from *Targets for Learning*.

Test Instructions

This math test matches the length of the actual Work Keys applied math test. Questions on the test reflect all of the math learning outcomes and also reflect the average difficulty of all math questions.

- Read each problem carefully.
- Underline key words and cross out (XXXX) unnecessary information.
- Use the information provided on the symbols and formula sheet, as needed.
- Use the blank area to the right of the problem to draw diagrams and make computations.
- Solve the problem. Then make an estimation to check your answer to see if it is reasonable.
- Write the letter of the correct answer in the appropriate space on your answer sheet.
- There is no penalty for guessing.

Questions on this math test are calculator neutral. Numbers within questions are designed to allow learners to figure out solutions in their heads, on paper, or with a calculator. Standard calculators may be used with this test. Calculators with advanced functions or with paper printouts are **not** allowed.

Mathematical Symbols and Formulas

Formulas

Rectangle
perimeter = 2(length + width)
area = length x width

Cube
volume = $(\text{length of side})^3$

Triangle
sum of angles = 180°
area = ½ (base x height)

For the following, let $\pi = 3.14$

Circle
number of degrees in a circle = 360°
circumference ≈ π x diameter
area ≈ $\pi \times (\text{radius})^2$

Cylinder
volume ≈ $\pi \times (\text{radius})^2 \times$ height

Cone

$$\text{volume} \approx \frac{\pi \times (\text{radius})^2 \times \text{height}}{3}$$

Ball
volume ≈ $\frac{4}{3} \times \pi \times (\text{radius})^3$

Amperage
amps = watts ÷ volts

Pyramid
volume = ⅓ Bh
(where B equals area of base)

Units of Measurement

Distance
1 foot = 12 inches
1 yard = 3 feet
1 mile = 5,280 feet
1 mile ≈ 1.61 kilometers
1 inch ≈ 2,540 centimeters
1 foot ≈ 0.3048 meters
1 meter = 1,000 millimeters
1 meter = 100 centimeters
1 kilometer = 1,000 meters
1 kilometer = 0.621 miles

Area
1 square foot = 144 square inches
1 square yard = 9 square feet
1 acre = 208.71 square feet
1 acre = 43,560 square feet

Weight
1 ounce ≈ 28,350 grams
1 pound = 16 ounces
1 pound ≈ 453,593 grams
1 milligram = 0.001 grams
1 kilogram = 1,000 grams
1 kilogram ≈ 2.2 pounds
1 ton = 2,000 pounds

Volume
1 cup = 8 fluid ounces
1 quart = 4 cups
1 gallon = 4 quarts
1 gallon = 231 cubic inches
1 liter ≈ 0.264 gallons
1 cubic foot = 1,728 cubic inches
1 board foot = 1in by 12 in by 12 in

Temperature
°C = .56 (°F − 32) or $\frac{5}{9}$ (°F − 32)
°F = 1.8(°C) + 32 or ($\frac{9}{5}$ x °C) + 32

Electricity
1 kilowatt-hour = 1,000 watt-hours

Learner's Response Sheet for Applied Math Tests

Name ____________________

Date ____________________

Circle one: Test A Test B

Circle one: Pretest Post-test Other ____________

Instructions: Write the letter of the correct answer on the appropriate line below.

Level 3

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________

Level 4

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________

Level 5

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________

Level 6

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________

Instructor's Answers to Applied Math Tests

Test A Answers

Level 3

1. C
2. E
3. C
4. E
5. E
6. B
7. C
8. E

Level 4

1. B
2. D
3. D
4. B
5. B
6. D
7. B
8. B

Level 5

1. D
2. C
3. B
4. A
5. A
6. A
7. D

Level 6

1. C
2. E
3. B
4. D
5. A
6. B
7. D

Test B Answers

Level 3

1. B
2. E
3. B
4. D
5. A
6. E
7. C
8. D

Level 4

1. B
2. D
3. B
4. C
5. D
6. E
7. B
8. A

Level 5

1. C
2. C
3. D
4. D
5. D
6. C
7. D

Level 6

1. A
2. D
3. B
4. C
5. E
6. A
7. D

Applied Math Test A

Level 3

1. The average weight of a newborn baby is 7 pounds. Most babies triple their birth weight by the end of one year. How many pounds will an average baby weigh at age one?
   - A. 10 pounds
   - B. 14 pounds
   - C. 21 pounds
   - D. 24 pounds
   - E. 28 pounds

2. Jackie walked 5 miles in the March of Dimes Walkathon. How many feet did she walk?
   - A. 28 feet
   - B. 1,000 feet
   - C. 5,280 feet
   - D. 10,000 feet
   - E. 26,400 feet

3. Coats regularly priced at $139 are now on sale for 50% off. What is the sale price of one coat?
   - A. $27.80
   - B. $65.00
   - C. $69.50
   - D. $70.00
   - E. $89.00

4. A parallel circuit has two branches. The currents of the two branches are measured at 2 amps and 1.5 amps. What is the total current in the circuit?
   - A. .5 amps
   - B. .75 amps
   - C. 1.7 amps
   - D. 2.15 amps
   - E. 3.5 amps

5. Chris has 16 ½ quarts of apple juice to distribute for breakfast in the school cafeteria. How many children can be served if each child receives 1 cup of juice?
   - A. 4
   - B. 6
   - C. 41
   - D. 64
   - E. 66

6. There are 3,500 potted plants in a greenhouse. Each potted plant must have a label. The labels are packaged 70 per box. How many boxes of labels are needed to label all of the plants?

   A. 5 boxes
   B. 50 boxes
   C. 500 boxes
   D. 2,450 boxes
   E. 2,800 boxes

7. A landscape plan requires Maria to purchase 5 azalea plants. Each azalea costs $15.95. How much must Maria pay for all 5 plants?

   A. $59.75
   B. $75.00
   C. $79.75
   D. $80.00
   E. $97.75

8. Susan has a sore throat. Dr. Smith orders an injection of 400,000 units of penicillin. The penicillin vial reads 200,000 units per cc. How many ccs did the doctor give Susan?

   A. ½ cc
   B. 1 cc
   C. 1 ½ cc
   D. 1 ¾ cc
   E. 2 cc

Level 4

1. Sally is preparing a batch of disinfectant solution to clean the infant-toddler center. The solution requires a formula of one cup of bleach to one gallon of water. How many cups of bleach must she add to 20 quarts of water?
   - A. 4 cups
   - B. 5 cups
   - C. 10 cups
   - D. 12 cups
   - E. 20 cups

2. The owner of the A-Z Print Shop decided to put new carpet in the employee break room. The room measures 30 feet by 30 feet. How many square yards of carpet will be needed to provide wall-to-wall carpet in the room?
   - A. 12 square yards
   - B. 30 square yards
   - C. 60 square yards
   - D. 100 square yards
   - E. 900 square yards

3. Mary has 3 pounds of apples; Tom has 6 pounds; Joyce has 2 pounds; and Jane has 1 ½ pounds. They need a total of 40 pounds. How many additional pounds do they need?
   - A. 12.5 pounds
   - B. 14 pounds
   - C. 26 pounds
   - D. 27.5 pounds
   - E. 28 pounds

4. A state law requires that there be one adult for every 10 preschool students enrolled in a state-certified school. How many adults are needed at a center with 200 preschool children?
   - A. 10 adults
   - B. 20 adults
   - C. 30 adults
   - D. 40 adults
   - E. 50 adults

5. Chris is making 16 bud vase arrangements with 2 carnations per vase. Carnations are sold in bunches of 25. How many full bunches of carnations will Chris need to purchase?

A. 1 bunch
B. 2 bunches
C. 16 bunches
D. 32 bunches
E. 50 bunches

6. A patient is given a prescription for tablets that must be taken 4 times a day for 7 days, and then twice a day for 7 days. How many tablets are required to fill this prescription?

A. 14 tablets
B. 28 tablets
C. 15 tablets
D. 42 tablets
E. 56 tablets

7. The director of Jones Preschool is serving fruit cocktail to 48 children. Each child will be served 4 ounces. How many 32-ounce cans of fruit cocktail will be necessary to feed all of the children?

A. 4 cans
B. 6 cans
C. 8 cans
D. 12 cans
E. 16 cans

8. Kimberly plans to make 10 large bows. Each bow requires 36 inches of ribbon. How many yards of ribbon does Kimberly need?

A. 3.6 yards
B. 10 yards
C. 13 yards
D. 30 yards
E. 60 yards

Level 5

1. Convert 35°C to its equivalent Fahrenheit temperature.
   - A. 31°
   - B. 63°
   - C. 67°
   - D. 95°
   - E. 120.6°

2. In the greenhouse there is a rolling bench measuring 5 feet wide and 12 feet long. What is the area of this bench?
   - A. 7 square feet
   - B. 17 square feet
   - C. 60 square feet
   - D. 65 square feet
   - E. 72 square feet

3. A construction worker earning $8.75 per hour receives an 8% increase in pay. What is the worker's new hourly rate?
   - A. $16.75
   - B. $ 9.45
   - C. $ 9.55
   - D. $ 9.58
   - E. $70.00

4. A printer is running a job that requires 2,000 sheets of 8 ½″ x 11″ paper. He cuts these 8 ½″ x 11″ sheets out of 17″ x 22″ sheets. How many sheets of 17″ x 22″ paper does the printer need to complete this job?
   - A. 500
   - B. 667
   - C. 750
   - D. 1,000
   - E. 2,000

5. A carpenter needs enough drywall to build a wall that is 20′ x 32′. The drywall comes in sheets that measure ½″ X 4′ x 8′ in size. How many sheets of drywall are needed to complete this job?
   - A. 20 sheets
   - B. 52 sheets
   - C. 84 sheets
   - D. 40 sheets
   - E. 672 sheets

6. Your office supervisor asks you to convert 1,230 minutes into hours. How many hours are equal to 1,230 minutes?

A. 20.5 hours

B. 60 hours

C. 117 hours

D. 129 hours

E. 205 hours

7. John has his eyes examined for new contact lenses and eyeglasses. The eye exam costs $65.00, the contact lenses cost $136.65, and the eyeglasses cost $196.72. Before he leaves the doctor's office, John must pay for his eye exam in full and put a 20% deposit on the remainder of his bill. What is the least amount of money that John would be expected to pay before leaving the doctor's office?

A. $ 65.00

B. $ 66.67

C. $ 79.67

D. $131.67

E. $398.37

1. Jerry made the following purchases and received a 25% discount on his total purchase price. He will have to pay 7% sales tax on the final cost of the items. How much will Jerry pay for this purchase?

Number	Item Description	Price
1	Stereo	$1,500.00
10	CDs	$10.99 each
3	Cassettes	$5.99 each
1	Storage cabinet	$150.00

A. $1,240.06
B. $1,337.75
C. $1,426.74
D. $1,777.87
E. $2,222.34

2. The average patient bill at Buckeye County Health Center is $48.00. Which one of the following five doctors had the highest billing charges for this 6-month period?

Number of Patients Seen by Doctors at Buckeye County Hospital
During the Months of June though December, 1996

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Dr. Vincent Dale	63	50	31	27	50	36	40
Dr. Elaine Elroy	10	35	76	63	41	23	76
Dr. Susan Nelson	52	37	81	27	41	56	70
Dr. Paul Porter	43	20	60	50	21	67	84
Dr. Joseph Van Elton	12	0	38	65	70	55	31

A. Dr. Elroy
B. Dr. Dale
C. Dr. Van Elton
D. Dr. Porter
E. Dr. Nelson

Targets for Learning: Applied Mathematics. Instructors may make copies for classroom use.

3. Mary worked the following hours during one week. She is paid $6.20 per hour for the first 40 hours of work. After 40 hours, she receives 1 ½ times her regular hourly rate. How much money did Mary earn this week?

DAY	HOURS WORKED
Monday	7.5
Tuesday	8.0
Wednesday	12.0
Thursday	8.25
Friday	10.75

A. $288.30
B. $308.45
C. $313.10
D. $410.75
E. $432.45

4. A ground cover bed in a landscape is 15 feet by 45 feet. The bed will be planted with 3 plants per square foot. The plants cost $18.00 per flat of 100. The nursery sells only full flats. How much will it cost to plant the bed?

A. $ 20.25
B. $ 54.00
C. $225.00
D. $378.00
E. $675.00

5. Stan is a mechanic's helper who earns $7.40 an hour, with time and a half for overtime. Under a new union contract, he will receive a 10% raise. Stan figures that he will receive $88.80 for working 8 hours of overtime under the new pay rate. If Stan made an error in his calculations, what was it?

A. He figured the overtime pay at the old pay rate.
B. He used a 15% raise instead of a 10% raise.
C. He figured the 8 hours at the new regular rate instead of time and a half.
D. He figured overtime for 7 hours instead of 8 hours.
E. He did not make an error in his calculations.

6. You are completing a job order on a vehicle in which a number of components were replaced. The customer will also be charged for labor. The prices are listed below. In addition to these charges, an 8% sales tax must be added to the job order. What is the customer's total bill if he receives a 5% senior citizen's discount on the total price of the parts.

Type	Description	Price
Parts	Brake line	$8.40
Parts	Brake lining	$17.95
Parts	Wheel cylinder	$13.95
Parts	Brake fluid	$5.95
Labor	Brake relining	$100.00

A. $136.68
B. $150.06
C. $156.54
D. $157.95
E. $160.44

7. The R. B. Jones Landscape Company is installing mulch at a site. The area of the site is 210′ x 148′. The mulch will be applied at a depth of 4″. Grade A premium mulch costs $31.00 per cubic yard. Grade B standard mulch costs $25.00 per cubic yard. How much would the company save by using Grade B mulch instead of Grade A?

A. $1,728.00
B. $2,274.00
C. $2,298.00
D. $2,304.00
E. $27,624.00

Applied Math Test B

Level 3

1. You go to the CD store with $48.00 in your wallet. CD's cost $12.00 each. How many CDs can you buy? (There is no sales tax.)
   A. 3 CDs
   B. 4 CDs
   C. 5 CDs
   D. 6 CDs
   E. 8 CDs

2. On Thursday the temperature fell from 17° Fahrenheit to –2° Fahrenheit. How many degrees did the temperature drop?
   A. –19 degrees
   B. –17 degrees
   C. 15 degrees
   D. 17 degrees
   E. 19 degrees

3. You spend approximately ¼ of your day working, ¼ sleeping and ½ doing miscellaneous tasks. What percent of your day is spent working and sleeping?
   A. .025
   B. .50
   C. .250
   D. .075
   E. .050

4. It takes 180 minutes to fly from Pittsburgh to Detroit. It takes 120 minutes to fly from Detroit to Chicago. How long are the combined flights?
   A. 1 hour
   B. 3 hours
   C. 4 hours
   D. 5 hours
   E. 6 hours

5. You are pre-assembling bolts and washers for the production line in your plant. You realize that you are about to run out of washers. You have 2 full boxes containing 500 bolts in each. The stock room has 3 open boxes of washers containing the following quantities, 176, 177, and 500. How many washers will you need to order so that you can match one washer with each bolt?

   A. 147

   B. 174

   C. 247

   D. 500

   E. 853

6. The Colorado Marble Company produces approximately 400 marbles a shift. On average, there are 25 defective marbles in every shift. If the company produced approximately 1,200 marbles in a day, how many defective marbles could we expect to find?

   A. 3 marbles

   B. 16 marbles

   C. 25 marbles

   D. 50 marbles

   E. 75 marbles

7. The trucking firm that your company uses to haul freight to its customers will hold only 900 pounds per load. If you have 6,750 pounds of material to be delivered, how many trips will the truck have to make?

   A. 7 trips

   B. 7.5 trips

   C. 8 trips

   D. 9 trips

   E. 15 trips

8. Select the false statement:

   A. $25\% = \frac{1}{4}$

   B. $25\% > 0.2$

   C. $50\% < 0.75$

   D. $50\% = \frac{1}{3}$

Level 4

1. Jennifer gets paid twice a month. The gross amount of each check is $360.00 She has the following deductions: $42.07 for Federal Income Tax; $15.35 for State Income Tax, and $25.95 for health insurance. She considered having $10.50 deducted for a savings account in the credit union, but decided against it. What is the amount of her paycheck after deductions?

   A. $266.13
   B. $276.63
   C. $302.58
   D. $317.93
   E. $349.50

2. The store where you work marks up the price of light bulbs by 25% per package. You must price some light bulb packages that cost the store $1.60. What price should you put on each package?

   A. $1.20
   B. $1.35
   C. $1.60
   D. $1.85
   E. $2.00

3. During an inspection, a machine operator found one defective part out of every 28 parts inspected. If 28 defective parts were found, how many parts were inspected?

   A. 28
   B. 784
   C. 786
   D. 824
   E. 1,084

4. A stereo originally cost $240.00. John bought it at a 15% discount. How much did he pay for the stereo?

   A. $36.00
   B. $180.00
   C. $204.00
   D. $225.00

5. A new construction job will take nine weeks and six days. A remodeling job will take three weeks and five days. How many days of work are required for both jobs?
   - A. 12 weeks 1 day
   - B. 12 weeks 4 days
   - C. 13 weeks 1 day
   - D. 13 weeks 4 days
   - E. 13 weeks 11 days

6. What is the area of a circle that has a radius of 5 cm?
   - A. 15.7cm^2
   - B. 13.4cm^2
   - C. 47.1cm^2
   - D. 62.8cm^2
   - E. 78.5cm^2

7. How many square yards of carpet are needed to cover a floor 12 feet by 14 feet?
   - A. 18 square yards
   - B. 19 square yards
   - C. 56 square yards
   - D. 144 square yards
   - E. 168 square yards

8. Your department builds parts Monday through Saturday. On Monday your department built 10 parts that took 10 hours total to build; on Tuesday your department built 5 parts that took 3.5 hours total to build; on Wednesday your department built 8 parts that took 7 hours 45 minutes total to build; on Thursday your department built 20 parts that took 8 hours total to build; on Friday your department built 12 parts that took 11 hours 15 minutes total to build and on Saturday your department built 3 parts that took 2.8 hours. Calculate the average hours per day required to build parts?
   - A. 7 hours 13 minutes
   - B. 8 hours
   - C. 10 hours
   - D. 10 hours 15 minutes
   - E. 58 hours

Level 5

1. A recipe book recommends $4\frac{1}{2}$ ounces of ham per serving. How much ham should Sue order for a party, if 24 people have been invited?
   - A. 6 lb
   - B. 6 lb $\frac{3}{4}$ oz
   - C. 6 lb 12 oz
   - D. 10 lb $\frac{2}{3}$ oz
   - E. 10 lb 8 oz

2. The mean of three numbers is 120. If two of the numbers are 90 and 140, what is the third number?
   - A. 90
   - B. 120
   - C. 130
   - D. 150
   - E. 240

3. Which of the following is a correct statement?
   - A. 1 mi < 1 yd
   - B. 2 mi < 5 yd
   - C. 2 km < 2 m
   - D. 1 ft < 1 yd
   - E. 1 ft > 1 yd

4. If you had one million pennies, how many dollars would you have?
   - A. $100,000,000.00
   - B. $1,000,000.00
   - C. $100,000.00
   - D. $10,000.00
   - E. $1,000.00

5. Casey bought a camera at a 15% discount. If the regular price was $96 and the sales tax rate is 8%, what net price did he pay?
   - A. $14.40
   - B. $81.00
   - C. $81.60
   - D. $88.12
   - E. $112.94

6. The average height of four boys was 67″. The heights of three were 64″, 68″, and 70″ respectively. How tall was the fourth boy?

A. 64″
B. 65″
C. 66″
D. 67″
E. 68″

7. Peter caught a fish that weighed 4 lb 3 oz. Later, on an official scale, the weight was 9 oz less. What was the official weight of Peter's fish?

A. 2 lb 15 oz
B. 3 lb 3 oz
C. 3 lb 4 oz
D. 3 lb 10 oz
E. 4 lb 12 oz

Targets for Learning: Applied Mathematics. Instructors may make copies for classroom use.

Level 6

1. Find the surface area of a rectangular solid 4′ wide, 8′ high, and 9′ long.
   A. 280 square feet
   B. 288 square feet
   C. 280 cubic feet
   D. 288 cubic feet
   E. 288 cubic yards

2. The volume of a rectangular solid is 216 cubic inches. Which of the following dimensions of the rectangle solid gives the *least* surface area?
   A. 2″ x 9″ x 12″
   B. 3″ x 9″ x 36″
   C. 3″ x 9″ x 8″
   D. 6″ x 6″ x 6″
   E. 24″ x 3″ x 3″

3. A rectangular aquarium is 14″ wide, 22″ long, and 9″ high. If the aquarium is filled to the top, how many gallons of water will it hold? (One gallon occupies 231 cubic inches of space.)
   A. 5.47 gal
   B. 12 gal
   C. 2,722 gal
   D. 291,984 gal
   E. 640,332 gal

4. On five consecutive days, a city's low temperature 5°C, –3°C, –5°C, –2°C, and 0°C. What was the mean low temperature for the five days?
   A. –3°C
   B. –2°C
   C. –1°C
   D. 0°C
   E. 5°C

5. If Bill, who is a truck driver, is allowed to drive only 8 hours at a time without sleep, how many miles can he travel at 55 miles per hour before he needs to sleep? ($d = r \times t$, where d = distance, r = the speed, and t = time)

A. 6 $^7/_8$ miles
B. 67.8 miles
C. 68.75 miles
D. 440 miles
E. 440 feet

6. Tanya exercises every other day. At what pulse rate will she start to achieve the most benefit for her heart? She is 40 years old. [$P = {}^3/_4(220-a)$ where P = necessary pulse rate and a = age]

A. 135 beats per minute
B. 180 beats per minute
C. 195 beats per minute
D. 205 beats per minute
E. 240 beats per minute

7. A coat was priced at $40.00 and has been reduced to $30.00. What is the percentage of discount?

A. 25%
B. 33 ⅓%
C. 50%
D. 75%
E. 133%

Learner's Test Score Summary Sheet

Use this sheet to record your responses to your applied math pretest or post-test. Follow the directions below to determine your Work Keys applied math level.

Instructions for the Learner:

1. Place a "✔" in the appropriate space for each correct response.
2. Place an "X" in the appropriate space for each incorrect response.
3. Tally the number of "X"s in each row (i.e., Level 3, Level 4, Level 5, and Level 6).
4. Record the number total of "X"s in the appropriate space in the far-right column of each row.
5. Focusing on this far-right column, start at Level 3 and read downward until you locate the **first** box in which you have the number 2 or above. Put an asterisk (*) to the right of that box. If your asterisk is beside Level 6, skip to instruction #7.
6. Find the box **directly above** the one you marked with an asterisk. Circle it. This is the applied math level at which you should begin instruction. (This level is meant to correspond with your Work Keys applied math level.)
7. Find your applied math level in the list located beneath the chart. Place a "✔" beside your level.

Now you're ready to begin your applied math instruction. Enjoy the learning!

	Question #1	**Question #2**	**Question #3**	**Question #4**	**Question #5**	**Question #6**	**Question #7**	**Question #8**	
Level 3									____ Xs at Level 3
Level 4									____ Xs at Level 4
Level 5									____ Xs at Level 5
Level 6									____ Xs at Level 6

My applied math level is:
(check one)

☐ **Below Level 3.** Starting at *Improving to Level 3* will best meet my current learning needs.
☐ **Level 3.** Starting at *Improving to Level 4* will best meet my current learning needs.
☐ **Level 4.** Starting at *Improving to Level 5* will best meet my current learning needs.
☐ **Level 5.** Starting at *Improving to Level 6* will best meet my current learning needs.
☐ **Level 6.** Starting at *Improving to Level 7* will best meet my current learning needs.

Applied Math Summary Sheet

Instructions:

1. Write learners' names down the column on the left.
2. In the first column after each name, write each learner's applied math score, according to the pretest.
3. Save the spaces in the next column for post-test scores.
4. Across the top of the chart, in the spaces to the right of where "Work Keys Post-test Level" is printed, enter the math and/or process skills that learners should be able to apply as they solve mathematical problems. (You may want to add these skills gradually because your goals may be modified as instruction progresses.)
5. Use the spaces below the math and/or process skills to record learners' performance on the learning activities and practice problems in *Targets for Learning*. If you wish, you can record the degree to which each learner can solve problems by making the following notations in the appropriate space:

IN = learner can apply content to solve problems INdependently

WA = learner can apply content With Assistance

CN = learner Can Not apply content to solve problems

Learner's Name	Work Keys Pretest Level	Work Keys Post-test Level								

Targets for Learning: Applied Mathematics. Instructors may make copies for classroom use.